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Source unit organizations in weather and physiography...

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Thesis

SOURCE UNIT ORGANIZATIONS IN WEATHER AND PHYSIOGRAPHY FOR NINTH-GRADE GENERAL SCIENCE

Submitted by

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Problem, Scope and Limitations, Procedure, and Recommendations.

Problem.-- The problem of this paper is the construction of related source unit organizations in weather and physiography for ninth-grade general science.

Scope and limitations.-- Activities proposed in the units are believed to be of sufficiently wide scope so that the use of them may readily be adapted to either city or rural classes in ninth-grade general science. The instructor desirous of spending less time and effort on the material than has been planned on in the paper may select such portions of principles of delimitations, and of core and related activities, as best appear to meet the needs of his students.

Normally the length of time apportionded should center around a two weeks' period, exclusive of the concluding examination. Ten 45-minute sessions in class are assigned to the unit in weather, and twelve periods in physiography.

Each unit organization is subdivided into key topics or branches of the respective physical sciences.

Procedure.-- Analysis of published weather and physiography units in text books and education magazines was made and recapitulation written out. Amount of space allotted to various topics in the newer textbooks was catalogued and put in table form. In this section of the paper, foundation of selection of principles and concepts was set up.

General aims for the weather unit were formulated.

Delimitation in outline form was then accomplished.

Techniques of introduction-motivation, core-base activities, as well as optional related work followed in sequence.

Each section was prefaced by a brief foreword.

Test material, including a diagram matching exercise, was prepared.

Listing of visual aid sources and materials was drawn up.

Similar procedures were followed for the unit organization in physiography.

Instructor and pupil references, with notes, were compiled.

Recommendations for further work and research.-- Actual teaching of the units to determine their practicability, and portions needing revision, should be carried out.

Testing validity and reliability of examination material should be made.

Additional comparison of these two units and unit assignments with published units and informal units now actually employed in schools is a future possibility.

Compilation of workbook exercises for these units appears feasible.

The problem, as defined in the first paragraph, could be approached effectively by (1) statement of the principle, (2) listing of its applications, (3) development of core work and optional related activities therefrom.

CHAPTER I

CHARACTERISTICS OF A GENERAL SCIENCE UNIT AS REVEALED BY A SURVEY

Published Units and Their Traits

Published units and courses of study.-- Published units and courses of study in weather and climate and typical unit organizations in physiography appearing in[1] general science textbooks and education magazines were read and analyzed by the investigator to ascertain the traits of this type of general science unit work. With this background as commencement, the writer should be better prepared to build unit systems of his own on the two related topics chosen, it was felt.

Heterogeneous characteristics.-- A general statement of findings must center around the heterogeneous characteristics noted throughout the unit organizations. In both form and content the units took on coats of variegated colors, and no evidence was found to support absolutely standardized categories for all units. This is not to imply, however, that there is any lack of certain phases common to units in general.

Structure and mechanics.-- Structure and mechanics were noted particularly. Length of the unit, as a basic governor,

1/ Bibliography appears on Pages 24 and 25.

appeared to be chiefly determined by (1) the purpose for which the unit was intended, (2) the school grade level for which the unit was built, and (3) space limitations of the publication in which the unit appeared. In the latter case abridgment of units from the original printing made it impossible to evaluate properly the intended product. At any rate, the units inspected ran the gamut of half-page offerings in grade teachers' magazines to detailed plans set forth in units drawn up in service paper and thesis work.

Courses of study compiled by teachers and other school officials in the larger city systems, of all the units contacted, placed in relief phases of structure and content which would prove most helpful in orienting one to the task of setting up new unit compositions of his own. For example, singular credit is merited by the World Book Encyclopedia loose leaf units.[1/] These seem to lend well to adaptation for use in nearly any size school, whether urban or country, having access to the well known repositories of knowledge. Objectives, alternative media, methods of motivation, unit activities of much variety, and reference lists combine to form quasi source units.

Two recommended systems.-- Jackson and Irving[2/] proposed, for sake of clarity and simplicity, these phases for a unit:

1/ M.S. Curry, and H.K. Holmes, "Weather and Climate," The World Book Encyclopedia Unit Teaching Materials. W.F. Quarrie, Chicago, 1941.

2/ Doyle D. Jackson and William B. Irwin, The Unit Method of Learning and Teaching. John S. Wright Co., St. Louis, 1942, p. 231-233.

the (1) setting, (2) general and specific objectives, (3) approach activities, (4) developmental activities, (5) cumulating activities, and (6) correlation with other subjects.

Integral sections of units organized on the Billett plan[1/] were built upon: (1) general statement of the unit, (2) itemized statement, or delimitation, (3) list of probable indirect and incidental learning products, (4) list of materials and references for teacher's use only, (5) unit assignment. The unit assignment, a complete, tentative and preliminary plan for teacher-pupil activity, was organized under the headings of: (a) introductory activities, (b) core activities, (c) optional related activities, (d) evaluative activities, (e) list of materials and references for pupils' use. Separate copy was prepared for the part of the unit assignment to be presented to the pupils by way of a General Study and Activity Guide, in addition to a comparable compilation to be utilized by the instructor for his own benefit. An objective test as well as format of brief inquiry to pupils for further evaluation purposes have been other essentials in the unit organization method under Dr. Roy O. Billett at the School of Education, Boston University.

1/ Roy O. Billett, Fundamentals of Secondary School Teaching. Houghton-Mifflin Co., Boston, 1940, p. 505-517.

Objectives of the Unit

Sources of objectives.-- Formulation of objectives is accepted by most writers and teachers as the initial step in the creation of a unit. In the process of setting up broad and specific aims, the writer drew from three sources for the weather-climate unit: (1) textbook authors, as to the amount of space they have devoted to single phases of the subject matter principles; (2) consensus among acknowledged writers in the science teaching field, as to the basic principles of general science directly applicable to weather and climate; (3) surveys of questions on general science topics in which pupils have actually expressed interest.

Both Table 1 and Table 2 reveal findings in textbook analysis of author emphasis on the many topics into which

this part of general science may be divided. The general trend veers toward the influence of weather phenomena on the daily life of man, his industries, health, recreation, and other phases of everyday life.

Objectives for secondary school students.-- In an attempt to bring into focus the chief principles of science with which the secondary school student should gain familiarity, a group of educators 1/ in the field of science outlined several specific objectives. The understanding of these principles should be objectives of instruction:

> There have been profound changes in the climate, not only of certain regions, but of the entire earth.
>
> The gravitational attraction between the earth and a mass of unconfined gas or liquid causes the pressure of the liquid or gas on the surface of the earth.
>
> Liquid or gas pressure is exerted equally in all directions.
>
> Certain material substances and certain physical conditions are limiting factors of life.
>
> The sun is the chief source of energy for the earth.
>
> Radiant energy travels in a straight line through a uniform medium.

Here we see treatment given to the physics of weather, but not to the social influences of weather and climatic conditions.

Objectives proposed by Craig and Burnett.-- Using three sources, namely (1) volumes of Nature Study Review, (2) professional literature, and (3) authoritative treatises on

1/ National Society for Study of Education, Thirty-First Yearbook, A Program for Teaching Science. Public School Publishing Company, Bloomington, Illinois, 1937. p. 53.

Three additional statements of broad aims.-- Greer[1] included in his list of aims the

(1) ability to explain nature's phenomena in a satisfactory manner
(2) development of inquisitiveness concerning science
(3) development of hobbies
(4) freeing from groundless fears and superstitions.

Twenty-two hundred school teachers[2] ranked among wide goals in science teaching the following (infinitively stated):

(1) to develop a better understanding of the environment
(2) to help to develop the power of observation
(3) to develop an appreciation of our environment
(4) to help develop attitude of freedom from dogma and superstition.

In view of the assumption that aims of this broad variety are as a rule taken for granted, their value in determining the destination of a unit appears considerably limited.

In a comparable vein, collaborators in the Year-book project[3] viewed educational values from science teaching as involving endeavor to increase the pupils'

(1) ability to understand how to utilize the findings of science that have applications to their own experiences
(2) ability to interpret the natural phenomena of the environment
(3) understanding of, and ability to use some of the methods of study that have been used by creative workers in the field of science.

1/ Willard Greer, "Aims....Governing Physics...." Science Education, (October, 1939) 23:262.

2/ William H. Hunter and Leroy Spore, "Objectives of Science in the Secondary Schools of the United States," School Science and Mathematics (October, 1943) 43:633-647.

3/ National Society for the Study of Education, Thirty-First Year-book, A Program for Science Teaching, 1927. p. 511.

(4) conviction of universal cause and effect relationships
(5) understandings that science aims to contribute to life enrichment.

What junior high school students want to know about science.-- An investigation into junior-high-school student questions about general science was made by Fleish,[1] who found that, among the voluntarily-submitted-in-writing questions, in the weather and climate field, were

(1) What causes the liquid in a thermometer to rise?
(2) How can you tell air has water in it?
(3) How is temperature of the air measured?
(4) How is the velocity of the wind measured?
(5) At 40,000 feet, what is the air pressure?
(6) Why does moisture return to the earth?
(7) Why is snow white when water is colorless?
(8) Why can't we see wind?
(9) Why do they measure air by inches?
(10) What makes glaciers?
(11) Why does water evaporate?
(12) How and why does it snow?
(13) What causes hailstones?
(14) What is a corona?
(15) What is frost?
(16) Why doesn't it rain when the evening is gray and the sun is red?
(17) What is rain and how is it made?
(18) Do clouds ever change their shape?
(19) What kinds of clouds are highest in the air?
(20) What does it mean by the term "conduction of weather"?

From these questions and numerous others Fleish drew up definite principles, comparing and contrasting the results with the concepts of general science appearing in better known textbooks. In more than one instance, hiatus between

1/ Sylvia Fleish, The Formulation of the Science Principles that Should Become the Objectives of General Science Teaching in the Junior High School. Unpublished Ed.M. Thesis at Boston University, 1945. p. 119-120.

expressed questions of students and author-selected material was obvious.

Specific statement versus general statement.-- Specific objectives are in some units listed in complete declarative statements; other authors prefer the brief infinitive enumeration, although the latter method may evoke indictment for dangling grammar. For example of this we look to one unit maker,[1] who included in the same column of objectives both precise aims and general goals:

(1) to gain partial information relative to the causes of ordinary weather changes and to develop an appreciation of the work of the Weather Bureau. (general)
(2) to realize we are at the bottom of the ocean of air. (specific)
(3) to understand the uses of weather instruments. (general)
(4) to know that the lower portion of heated air absorbs moisture better than the upper part. (specific)

Objectives in grades below high school.-- Brown[2] based the material he used in Senior high school general science on four needs of the pupils, involving

(1) a rational world picture
(2) a workable philosophy of life
(3) understanding of material use, and use of natural resources
(4) understanding of students' own physiological functions.

1/ Bulletin of State Department of Education, Texas High Schools, The Teaching of Science (September, 1931) p. 36.

2/ H. Emmett Brown, The Development of a Course in the Physical Sciences for the Lincoln School, New York: Teachers College, Columbia University Press, 1939, p.26.

Young[1] proposed to teach fifth grade children to "....forecast with a fair degree of accuracy." Here is an instance of a goal far beyond any possibility of realization.

Pupils of the Raub Junior High School of Allentown, Pa.,[2] set up their own purposes for a weather club, which met after school time. They wanted their club (in their own words)

(1) to satisfy our interest and increase our knowledge of weather
(2) to supply a daily weather report to our school and the homes represented
(3) to make our Weather Bureau a source of pride of the Raub school.

Digest of principles by Steinwachs.-- In synthesizing and organizing principles of many previous compilations, Steinwachs[3] telescoped these general declarations in his master list:

(1) The principle cause of wind and weather changes is the unequal heating of different portions of the earth's surface by the sun; thus all winds are convection currents caused by unequal heating of different portions of the earth's atmosphere, and they blow from places of high pressure to places of low atmospheric pressure.
(2) Bodies of land heat up and cool off more readily than bodies of water.

1/ D. L. Young, "A Schoolroom Weather Bureau," Instructor (March, 1943) 52:33.

2/ Kermit J. Blank, "The Weather Club," School Science and Mathematics, (January, 1937) 37:62.

3/ Carl M. Steinwachs, Synthesis and Organization of Secondary School Chemistry and Physics Principles. Unpublished Ed.M. Thesis at Boston University School of Education, 1946. p. 126.

(3) Air has a tendency to move from a region of higher pressure to one of lower pressure; the greater the difference, the faster the movement.
(4) Due to the rotation of the earth, in the northern hemisphere winds are deflected to the right, and in the southern hemisphere to the left.
(5) In moving air the wind pressure is proportional to the square of the velocity.
(6) Air pressure decreases with an increase in water vapor content, or with an increase in temperature.
(7) The higher the temperature of the air, the greater the amount of moisture required for saturation.

Major goals in science instruction.-- Downing 1/ formulated his major goals for science teaching in terms of a vital connection of science with everyday life situations. His road would lead to

(1) the acquisition by the pupils of those skills that are based upon the most scientific knowledge- important because it enables pupils to solve the problematic situation that involves science as it arises in their lives, problems of health, of home, of vocation, and the like.
(2) the development in pupils of skills in scientific thinking- a knowledge of the elements in the process, an awareness of the safeguards that must be observed to prevent erroneous conclusions, and much practice in the art.
(3) the establishment in the pupils of those major emotionalized standards inclusive of the multitudinous desires, dispositions, and attitudes that serve as the motive of the many daily acts that involve science.

The scientific attitude.-- Concerned with secondary level science instruction, Haas 2/ stressed the importance of teaching the scientific attitude as an approach to

1/ Elliot R. Downing, An Introduction to the Teaching of Science. University of Chicago Press, Chicago, 1934. p. 7.

2/ H. B. Haas, "Objectives of Science Teaching," School Science and Mathematics, (January, 1946) 46: 46-50.

problems in all phases of life. In view of the fact that students now in high school will one day run the affairs of the nation, the writer posed the questions:

> Will they have retained any vestige of the idea that the most powerful force for change in modern society is scientific research?
>
> In an age when atom bombs are capable of destroying a nation overnight, will they be willing to face facts in the spirit of science? Can we, as scientists, teach the scientific attitude as an approach to all problems of life?

Compilations of principles by Wise and Jones.-- From master lists covering the field of the physical sciences drawn up by Wise[1] and Jones, this writer has secured extraction of those principles pertaining to weather and physiography. Classification of topics under headings was made by the organizer of this paper, not by Wise or Jones. Original number designations of Wise have been retained. Principles are here repeated, insofar as feasible, by topical arrangement. "W" indicates a Wise principle; "J" denotes a Jones principle.

AIR PRESSURE:

4. A fluid has a tendency to move from a region of higher pressure to one of lower pressure; the greater the difference, the faster is the movement. (W)

12. The pressure in a fluid in the open is equal to the weight of the fluid above a unit area including the point at which the pressure is taken; it therefore varies as to the depth and average density of the fluid. (W)

26. If the same pressure is maintained, the volume of a gas varies directly as the absolute temperature. (W)

66. The volume of an ideal gas varies inversely with the pressure upon it, providing the temperature remains constant. (W)

The pressure of the atmosphere becomes less as the distance above the earth's surface becomes greater. (J)

1/ Harold E. Wise, "Determination of the Relative Importance of Principles of Physical Science for General Education," Science Education, 25:371-9 (Dec. 1941) and 26:8-12 (Jan. 1942)

Air moves from points of greater pressure to points of lesser pressure, causing air currents or winds. (J)

Whenever air is heated, it expands and becomes lighter, and is pushed upward by the greater pressure of the cooler and heavier air surrounding it. (J)

TEMPERATURE:

32. The higher the temperature of the air, the greater the amount of moisture required to saturate it. (W)

61. The atmosphere of the earth tends to prevent the heat of the earth's surface from escaping, and the earth begins to cool only when the amount of heat lost during the night exceeds that gained during the day. (W)

74. The lower the temperature of a body, the less the amount of energy it radiates; the higher the temperature, the greater is the amount of energy radiated. (W)

22. Most bodies expand on heating and contract on cooling, the amount of change depending upon the change in temperature. (W)

29. Heat is transferred by convection in currents of gases or liquids, the rate of transfer decreasing with an increase in the viscosity of the circulating fluid. (W)

Differences in temperature cause differences in atmospheric pressure, and these differences in atmospheric pressure cause winds. (J)

EVAPORATION, CONDENSATION, PRECIPITATION:

62. The rate of vaporization decreases with an increase of concentration of the vapor in the gas in contact with the liquid, the temperature remaining constant. (W)

65. Condensation will occur when a vapor is at its saturation point if centers of condensation are available and if heat is withdrawn. (W)

3. The rate of evaporation of a liquid varies with temperature, area of exposed surface, saturation, and circulation of the gas in contact with the liquid. (W)

The higher the temperature of the air, the greater the amount of moisture that is required to saturate it. (J)

When air is cooled sufficiently, the moisture in it condenses. (J)

If the temperature rises or falls, the amount of water vapor the air can hold also increases or decreases. (J)

Evaporation follows precipitation, and precipitation follows evaporation in endless succession. (J)

WIND:

10. The principal cause of wind and weather changes is the unequal heating of different portions of the earth's surface by the sun; thus all winds are convection currents caused by unequal heating of different portions of the earth's atmosphere, and they blow from places of high atmospheric pressure to places of low atmospheric pressure. (W)

Air moves from points of greater pressure to points of less pressure, causing air currents or winds. (J)

Differences in temperature causes differences in atmospheric pressure, and these differences in atmospheric pressure cause wind. (J)

103. In the Northern Hemisphere great volumes of air revolve in a counterclockwise direction, and in the Southern Hemisphere, they revolve in a clockwise direction. (W)

121. In moving air, wind pressure increases as the square of the velocity. (W)

BUILDING UP AND WEARING DOWN OF THE EARTH

244. The natural movements of air, water and solids on the earth are due chiefly to gravity plus rotation of the earth. (W)

246. The earth's surface may be elevated or lowered by interior forces. (W)

247. When elevations or depressions are created upon the surface of the earth, the elevations are usually attacked by the agent of erosion, and the materials are carried to the depressions. (W)

248. The rate of erosion is inversely proportional to the resistance of rocks to decomposition and disintegration. (W)

249. Continual erosion results in decreasing the average density of continental masses and continual deposition in increasing the average density of rocks under the ocean. (W)

BODIES OF WATER:

250. Streams, generally, are lowering the surface land in some places and building it up in others. (W)

251. Streams, potentially, have a regular cycle, consisting of youth, maturity, and old age. (W)

252. Falls or rapids tend to develop in a stream bed where the stream flows over a hard stratum to a soft one. (W)

253. The transporting power of streams varies approximately as the fifth power of the velocity. (W)

GLACIERS:

254. Glacial condition are as a rule approached by increasing latitudes or altitudes. (W)

255. Glacial abrasion occurs in proportion to the weight of the ice and the velocity of its movement. (W)

INNER EARTH FORCES:

256. Under high pressures which occur in the earth's interior, materials that usually are solid have the capacity to flow slowly and thus bring about equalization of pressure differences on the surface. (W)

257. Forces within the earth may cause breaks to appear in the earth's crust. (W)

258. Earthquakes are produced by the sudden slipping of earth materials along faults.

MOUNTAINS, ROCKS, SOIL:

259. Rocks may be folded to form mountains. (W)

260. Igneous rock may be formed from materials intruded into other rocks.

261. Rocks may be formed by the cooling and solidifying of molten material. (W)

262. Rocks may be formed by the compacting and cementing of sediments. (W)

263. Rocks may be metamorphosed, or changed by heat, pressure, and flexion. (W)

264. Parent material for the development of soils is formed thru the physical disintegration and chemical decomposition of rock particles and organic matter. (W)

<u>How Wise compiled his principles</u>.-- The purpose of the investigation conducted in 1941 by Harold E. Wise, the supervisor of sciences, Teachers College, University of Nebraska, was the determination of what principles of physical science, in the fields of physics, chemistry, and biology, are most important for general education.

Four studies published in the five years previous to 1941 served as sources in the development of a tentative list for use in the Wise investigation. These principles were set down on cards and transferred to a master list.

Wise had already decided on his criteria. A principle had to be "a comprehensive generalization describing some fundamental process, constant mode of behavior, or property relating to natural phenomena"; it had to be "true without exception within limits specifically stated...capable of illustration... not a definition."

With two members of the science staff of a school of education, Wise deleted all principles that could not meet the criteria, or could not be reworded to fulfill requirements. In all, 252 principles were found to satisfy the criteria.

The head of the Department of Physics at the University of Michigan carefully checked each principle against the investigator's criteria, and made suggestions for restatement. As a result, 191 of the 252 principles were restated.

From an analysis of eleven physics, chemistry, and general science textbooks on the high school and junior college

levels, a total of 3,403 applications was assigned to appropriate principles.

This entire list of principles and applications was submitted to four competent, experienced college teachers of science for checking "(1) the adherence of applications to the criterion of practical and cultural value, (2) the assignment of applications to principles involved in their explanation, (3) the possible duplication of applications appearing under any one principle." By this refinement, the number of applications was reduced from 3,403 to 3,153.

To the 252 principles we have already noted, twenty were added as a result to the appearance of applications which could not be assigned to any of the 252 principles. Then, applications were applied to 246 of the 272 principles in the composite list.

. Among the 20 principles receiving the highest ratings were these, in order of importance, pertaining to weather:

1. A fluid has a tendency to move from a region of higher pressure to one of lower pressure; the greater the distance the faster the movement.

7. Heat is transferred by convection....

9. When two bodies of different temperature are in contact, there is a continuous transfer of heat energy, the rate of which is directly proportional to the difference in temperature.

11. Most bodies expand on heating and contract on cooling, the amount of change depending on the change of temperature.

12. The pressure in a fluid in the open is equal to the weight of the fluid above a unit area....

14. The volume of a gas varies inversely with the pressure upon it, providing the temperature remains constant.

17. Condensation will occur when a vapor is at its saturation point if centers of condensation are available and if heat is withdrawn.

. In the remaining sections of the investigation the results of the evaluation which has been described here were synthesized with the results obtained in eleven earlier research studies in the field of science education.

How Ruth Jones secured list of principles.-- Purpose of the investigation was determination of the principles of general science stated in recently published ninth-grade textbooks.

Criteria were set up in declarative sentence form.

Seven ninth-grade textbooks, published since 1940, were chosen.

Sentence analysis was made to discover generalized statements satisfying the criteria.

Eleven subject matter divisions were made, and all statements filed under one particular heading.

Validation was effected by (1) comparison with principles of science contained in three doctoral theses (2) judgment of field specialists.

Data were tabulated to indicate number of principles belonging to (1) textbook divisions (2) eleven arbitrary divisions (3) the physical and biological sciences by comparison.

How subject matter of the delimitations was selected.--The foregoing digest of general and specific aims was made to bring into relief the sources of, and authority for, the principles and understandings that comprise the delimitations.

In many instances, a unit deviser may extract principles or concepts virtually or totally verbatim from statements as set down by authoritative writers. However, in other cases, and to avoid making a fetish of compiled principles, a unit maker must necessarily choose, cull, synthesize, and organize the major and minor central ideas of his unit, in keeping with his own past experience and present judgment.

A catalogue of the authorities dealt with may aid the reader of this section in recapitulation and in reference.

GENERAL AIMS:

Writer or Group	Page
Craig	5
Burnett	5
Greer	6
School teachers	6
Texas Bulletin	8
Brown	8
Young	9
Junior high pupils	9
Downing	10
Haas	10

SPECIFIC AIMS:

Writer or Group	Page
Thirty-First Yearbook	4
Fleish	7
Texas Bulletin	8
Steinwachs	9
Wise	12
Jones	12
Table 1	22
Table 2	24

TABLE I. PERCENT TALLY OF EIGHTEEN GENERAL SCIENCE TEXTBOOKS GIVING AT LEAST ONE PARAGRAPH TO PHASES OF WEATHER AND CLIMATE AS ADAPTED FROM FINDINGS OF RICHARD E. JASON, IN THE USE OF FILMS IN TEACHING THE UNIT WEATHER IN GRADE NINE. UNPUBLISHED ED.M. THESIS AT BOSTON UNIVERSITY, SCHOOL OF EDUCATION, 1938. CHAPTER IV, PAGES 50-54.

Topic	Percent
Cyclone and anticyclone	100*
Effects of bodies of water on climate	100
Water cycle	100
Rain	94
Hygrometer	88
Winds	88
Temperature	88
Air pressure	88
Thunderstorm	82
Tornado	82
Dew	82
Frost	82
Sleet	82
Weather forecasting	77
Weather maps	77
Weather Bureau	72
Weather (definition)	72
Relative humidity	66
Condensation	66
Fog	66
Snow	66
Cold air versus warm air	60
Hail	60
Angle of rays of sun	55
Ci, st, cu, nb (separate)	55
Wind paths in United States	55
Weather and occupations	50
Table of relative humidity	50
Barograph	50
Anemometer	50
Land and sea breeze	50
Thermometer	50
Weather and health	44
Climate	44
Storm areas	44

*The table is read thus: Of the 18 books surveyed, the entire number, or 100 percent, allocated at least one paragraph to the topic of cyclone and anticyclone.

Table 1 concluded:

Topic	Percent
Evaporation	44
Rain guage	44
Trade winds	44
Thermograph	38
Weather signs	28
Aneroid barometer	28
Lightning	28
Rainfall	22
Cloud combinations	22
Altimeter	6
Layers of atmosphere	6
Hurricane	6
Weighing air	6
Storms (special)	6

TABLE II. AGGREGATE NUMBER OF PAGES IN EIGHT NINTH GRADE GENERAL SCIENCE TEXTS, EACH PAGE CONTAINING AT LEAST ONE PARAGRAPH DEVOTED TO A TOPIC IN WEATHER AND CLIMATE.

Topic	Number of Pages
Air pressure	78*
Weather Bureau	65
Wind and wind regions	60
Rain	44
Barometer	31
Water cycle	29
Ci, st, nb, cu	28
Humidity	28
Condensation	26
Thermometer	25
Weather maps	25
Tornado	23
Thunderstorm	22
Cyclone and anticyclone	22
Temperature	20
Climate	20
Lightning	18
Wind belts	16
Snow	14
Dew	13
Frost	13
Hail	11
Anemometer	11
Rainfall	10
Land and sea breeze	9
Barograph	9
Layers of atmosphere	9
Seasons, cause of	9
Signs and superstitions	8
Weather (definition)	8
Hurricane	8
Health	7
Climates, changing	7
Fronts	6
Industry	6
Thermograph	6
Sleet	3
Dew point	3
Rain gauge	1
Psychrometer	1

*Table 2 is read thus: In the eight books surveyed, a grand total of 78 pages (with each page having one or more paragraphs in treatment of the topic) was given over to discussion of the subject of air pressure.

BIBLIOGRAPHY OF TEXTS ANALYZED FOR TABLE 2

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CHAPTER II

UNIT ORGANIZATION IN WEATHER

General Aims

Foreword.-- General aims of this unit were drawn up after study of principles and objectives as determined by leading textbook writers, investigators of the significant concepts that should become the backbone of the delimitation of a unit organization, and designers of both published and unpublished units in sources already considered in this paper. Although the wording of the statements here is original, the ideas are common property of practically all writers and thinkers who have dealt with the problem of objectives.

Effort has been made to keep all objectives within the bounds of a feasible chance of realization.

The aims listed.-- Work in the unit should

(1) give the student opportunity to satisfy his curiousity about the nature and workings of (i.e., the physics of) climate and weather phenomena that so vitally influence his everyday life;

(2) enable the student to become familiar with, as far as unit time permits, the basic principles of climate and weather as bounded by the delimitation of the paper;

(3) motivate the student to find out more than he already knows about weather and climate in his own home town;

(4) provide for individual differences by including various optional activities, one or more of which should appeal to each pupil, with the manual or other artistic creative field especially in mind;

(5) suggest a further study of weather and climate as a worthy use of leisure time;

(6) show the student the interrelation of weather-climate and phases of agriculture, commerce, biology, physiography, and economic geography;

(7) increase the facility of the student in the use of reference books, indexes, bibliographies, Government Printing Office publications, reading of tables and graphs, interpretation of maps;

(8) increase the student's acuity of observation with reference to weather phenomena;

(9) correct tendencies of the pupil who falls victim to superstitions about weather and climate, and show him the value of making tentative conclusions from all evidence now on hand;

(10) emphasize importance of services performed by the Weather Bureau, so that the student may come to better understand and appreciate work accomplished by government agencies of this type.

Delimitation

I. Scope of weather and climate.-- Without the sun there would be no heating of the earth's atmosphere, and consequently neither climate nor weather could exist.

A. Difference in the heating of the earth's surface varies with the time of year, and is determined by the inclination of the earth's axis as the earth revolves about the sun, resulting in constant change of the angle at which the sun's rays strike the surface of the globe.

1. Ability of the earth's surface to absorb and radiate heat rays varies.
2. Physiography of the terrain helps determine whether heat will be absorbed or reflected.
3. Mountain ranges may cut off cold winds.

B. Although exactly the same atmospherical principles of science determine the nature of weather and climate, climate implies atmospheric condition averages over a long period of years, while weather refers to the status of the air area at a place at a single, specified time.

C. Scientists recognize as many as twenty-five different types of world climate types, with highly variable annual distribution of, degree of, and amount of

precipitation, temperature, winds, length of seasons, and the like.

D. Climate profoundly modifies the activity of people of the world, as a tremendous influence on people's choice of occupations, recreations, customs, and philosophies of life.

E. Climates in different sections of the earth have been altered greatly over periods of geologic history, and are believed to evolve in some sort of cycles, as revealed by study of tree annual layer growth, sun spots, deposition of soil, volcanic material and river deposits, glacial action. Regions now well watered once were deserts, and the opposite is likewise believed to be the case.

F. Climate largely determines where men will live on earth, and the type of life that they will lead. All animal and plant life is dependent on climate, to which physical makeup and personal characteristics, mode of life, structure of abode must make adaptation.

1. Agriculture, first of all, and to a large extent industry and commerce are subject to climatic influence and control.
2. Climate likewise decisively acts on the health conditions and vigor of any people. Comfort and

disease are in close alliance with weather and climate in a host of instances.

a. The practical objective in clothing and housing should be the aiding of the body to maintain the balance necessary between the production of heat, and heat loss, with a minimum of effort. High relative humidity helps to prevent heat loss from the body, and consequently makes high temperatures much less bearable. Fanning and dehumidifying the air both help the body to give off excessive heat. In a dry, parched atmosphere, the mucous membranes of nose and throat tend to become dry, and susceptibility to respiratory trouble increases. In the heating of a house, it is necessary to make provision for mixing of cold and warm air.

b. Adjustment to a new climate presents a serious problem, as several physiological processes of the body must operate at a somewhat different degree. In the tropics, a greatly increased supply of both salt and water must be consumed. Shade and white clothing help to reduce amount of heat taken on from the sun's rays. While skin tan helps to increase resistance to ultraviolet radiation, one must guard against sunburn.

c. Few health maladies are caused directly by unfavorable conditions of weather or climate. Exceptions are heatstroke, snowblind malady, frostbite, and mountain sickness. Weather and climate tend to favor organisms that cause disease, such as malaria, hookworm afflictions, and influence the individual's RESISTANCE to disease. Common colds, pneumonia, infantile paralysis, heat cramps, heat exhaustion all are known to be related to climate, weather, and seasonal atmospheric conditions. But climate is less to blame for health ills than poor nutrition, overcrowding, inadequate sanitation and lack of medical care.

G. Climate as a world influence may be studied in terms of

1. a phenomenon that changes thru the ages; human beings have seen only the more violent moods of the earth, not the long periods of climatic congeniality, characterized by
   a. unrest in the crust of the earth, in form of earthquakes, volcanoes, upthrusting of mountains, extensive deserts, retreat of the oceans;
   b. icecaps in the polar regions sometimes extending far down into low-temperature zones;

2. the close relationships between climate, vegetation and soil, in the three chief types of climate regions in the world- moist, dry, and cold.

II. Temperature.-- Temperature refers to the degree of heat possessed by any solid, liquid, or gas. Important traits and attributes of temperature follow.

A. Alteration of temperature of masses or sections of air and of land and water bodies brings about all changes in weather conditions- air pressure, clouds, wind, precipitation, humidity, obstructions to vision.

1. Heat near the surface of the earth is prevented from escaping by the atmosphere curtain.

2. Degree of temperature of a body limits the amount of heat it may radiate.

3. Most bodies expand on heating and contract when cooled.

4. In masses or currents of gases or liquids heat is transferred by convection.

B. Present temperature is usually measured by the thermometer; the thermograph permanently records all temperatures; the maximum thermometer registers highest reading in a given period; minimum thermometer registers the lowest temperature occurring in a specific length of time.

C. Heat causes the mercury or alcohol in an indicating thermometer to expand and rise in the bore, while lack of warmth results in contraction and a descending of the fluid. Alcohol, because of its low freezing point, is used to measure air temperature (in practice) from -20 to -90 degrees F.

D. The U. S. Weather Bureau maintains a running record of temperatures thruout the nation, and uses this data for forecasting purposes, as well as for daily, monthly, and yearly summation in the study of climate from a research point of view.

III. <u>Air pressure</u>.-- Significant principles of and important points about air pressure are to be found in:

A. Air pressure is due to the weight of the air above the earth, or the pull of gravity on masses of air. Since the density of the air decreases with altitude above the earth, air pressure grows less as one ascends. Whenever air is heated, it expands and becomes lighter, and is pushed upward by the greater pressure of the cooler, heavier air rushing in to replace it. Air is forced to move from points of higher pressure to places of lower pressure, the greater the difference in the pressure of the fluid the faster the movement.

B. Low pressure air masses contain more moisture in form of water vapor than high pressure areas, and this affords opportunity for formation of clouds and frequently precipitation.

C. Air pressure, exerting force on the liquid surface of a mercury column in a cistern, will force the mercury, in a tube one inch in cross section (from which air has been expelled), to a height of 29.92 inches above the resevoir of mercury, under standard conditions. The instrument, the mercurial barometer, was invented by Torricelli, Italian physicist, in the first part of the seventeenth century.

D. The aneroid barometer is a small metal evacuated box, top of which moves up when air pressure decreases, is pushed in when pressure of the air increases; movements are communicated to a pointer which moves over a scale. The altimeter is a type of aneroid barometer, as are the barograph and microbarograph, two self-recording barometers.

E. A cyclone is any mass of air moving spirally counter-clockwise inward toward a low pressure area. The anticyclone (or "high") is a mass of air moving spirally outward clockwise from a center of high pressure.

1. Cyclones move about the earth from west to east and cause the ordinary storms every few days in the region of the prevailing westerlies.
2. Cyclones (or "lows") usually bring cloudy or stormy weather.
3. Anticyclones (or "highs") customarily bring fair, clear, or cool periods of weather.
4. Roughly oval in shape, cyclones may extend over an area of several thousands of square miles, at greatest extent.
5. Owing to the rotation of the earth, inflowing air is deflected to the right on the Northern Hemisphere. Conditions are reversed in the Southern Hemisphere.

IV. and V. Winds and wind regions.--

A. The winds of the world show characteristically different traits at the various latitudes.

1. The section of the earth in the so-called torrid zone is known as the heat equator or the belt of equatorial calms. Like all other belts this one shifts north and south with the seasons. It receives a vast amount of heat from the sun. The air over the region is heated, grows lighter, rises, is replaced by air from the north and south. The air appears generally calm because

of movement upward in dense masses, resulting in a great supply of rainfall.

2. Immense masses of air rising from the belt of equatorial calms to higher levels flow north and south, gradually shifting to the east, forming Anti-Trade winds. A portion of this dry air mass settles to the earth drying land and producing deserts like the Sahara and Gobi.
3. Air descends from the Horse Latitudes to the north (in the northern hemisphere) to create the same Trades mentioned in the previous paragraph. Name comes from the fact that trading vessels formerly depended on them for propulsion.
4. The Horse Latitude areas, subtropical regions of calms, receive warm air from the Anti-Trades and from air masses at high levels en route from the poles equatorward.
5. Sections of air masses high aloft flowing from equator to pole settle down as Prevailing Westerlies. Due to the earth's rotation, winds flow from the west, northwest and southwest more than from the other points of the compass, and the general circulation of the air is from west to east.
6. Winds in the polar regions appear to flow out from the poles in a more or less easterly direction

toward zones in the regions of from sixty to sixty-five degrees north and south latitude. Here the cold easterly winds come in violent contact with relatively warm westerly winds. This action between conflicting air currents may produce cyclones and anticyclones.

B. Wind storms indigenous to the United States are known for a number of traits.

1. Storms in the United States usually originate in the northwest, southeast, or south, but move as a rule northwest (in the two latter instances) before swerving eastward. They travel at from 500 to 900 miles each day, the lower rate in summer due to the less marked difference in air pressure of the two chief seasons. Storm centers generally pass out to sea over the Atlantic Ocean at or near the Gulf of the St. Lawrence.

2. Wind in the United States is measured in terms of miles per hour passing a station, where direction is indicated by the wind vane, and speed by the anemometer.

3. Special types of wind storms, usually accompanied by precipitation, are the hurricane, the tornado, the thunderstorm.

a. The hurricane, an extremely violent cyclonic storm of the tropics, in which the air pressure is very low in comparison to the surrounding vortex, originates near equatorial areas, and is accompanied by torrential rains, and ordinarily moves west and north to about twenty-five or thirty degrees north latitude in our hemisphere.

b. The tornado is a violent, small-area wind storm, taking place on hot, humid days, when there is great clash between several currents of air differing widely in temperature. Becoming a funnel-shaped whirling mass of debris, the tornado occurs on our prairie states, where chaotic amounts of damage may be done in a very short time.

c. The thunderstorm will be dealt with in Section VII of this chapter.

VI. Clouds.-- Chief facts about clouds are:

A. Clouds come from condensation of moisture on countless minute particles of dust, of salt from evaporated ocean water, and of electric charges, at levels of plus six miles above the surface of the earth.

1. Particular clouds are by their very nature found at characteristically different levels:

a. Low clouds, with bases less than 6,500 feet above terrain, are chiefly cumulus, cumulonimbus, stratocumulus.

b. Middle clouds, between 6,500 and 20,000 feet high, consist chiefly of altostratus, as well as altocumulus clouds.

c. High clouds, ranging from 20,000 to 30,000 feet base level above the ground, include cirrus, cirrostratus, and cirrocumulus clouds.

2. Cumulus are dense, with vertical development. The upper surface is roughly dome-shaped and has rounded protuberances. Base is nearly flat and horizontal.

3. Stratocumulus are laminae-shaped, globular masses or rolls. Usually arranged in layers or patches, they have ill-defined edges; their gray color varies in shading and hue; they may be arranged in uniform patterns of dark gray.

4. Cumulonimbus comprise dark heavy masses of well developed, vertical cumiliform, with summits that rise in the form of anvil shaped towers. Rain or hail showers are usually produced, along with lightning and thunder.

5. Altostratus have striated, fibrous texture, and are more gray or blue in color. They vary in

thickness, either completely obscuring sun or moon, or permitting vague shining through. Snow and light to moderate rain descend from this type of cloud.

6. Altocumulus are made up of masses of clouds laminae-shaped or flatened globule shaped, appearing in layers, patched groups, waves, or rows. Checkerboard effect may be produced.
7. Cirrocumulus are small, white masses of clouds, globular in appearance, ordinarily part of a patch or layer, and resembling close rows like ripples in the sands of a beach.
8. Cirrostratus are thin, white veiled clouds, diffuse and giving the sky a white hue at times, and are never too thick to prevent the sun from coming thru to cast a shadow on the earth.

VII. <u>Precipitation and obstructions to vision</u>.-- Understandings here find main basis on:

A. Precipitation occurs when the sun and gravity act on water vapor in the air. Temperature, pressure, humidity and wind all react simultaneously and interdependently under fixed laws of nature to give the earth several possible forms of condensation, either local or over a wider area, to bring on rain, snow, hail, sleet, fog, frost, dew.

B. Relative humidity, evaporation, and condensation are important terms used in explaining the water cycle.

1. Relative humidity is the ratio of the amount of water vapor contained in a volume of air at a particular temperature to the amount of water vapor that could possibly be held in the air at the prevailing temperature. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it.
2. The rate of evaporation of water from the surface of the earth depends on the amount of water vapor in the air, temperature of the air, air pressure, and air movements.
3. Condensation is the process of forcing water vapor out of the air by decreasing the temperature of the air mass, and forming small droplets on the surface objects, in clouds, frost, dew, or fog. Condensation and precipitation work in turn with evaporation in the endless water-vapor cycle.

C. Fog is veritably a cloud at ground level, and water vapor condensed in form of minute water droplets, which interfere with horizontal visibility. At night, when the air near the ground cools off when no clouds are present to act as a heat blanket,

water vapor may be condensed as DEW because the air cannot hold the water vapor at the lower temperature. If the temperature registers below freezing under such conditions, FROST is formed. SLEET is frozen rain which has passed thru a layer of air of freezing temperature. HAIL, born only in the whirling clouds of a thunderhead as a rain drop that is carried by an ascending current to a high portion of the cumulonimbus cloud and there frozen, repeatedly rises and falls, gathering a coat of moisture in the warmer layer, only to be frozen with another coat in the colder upper air.

D. THUNDERSTORMS involve the generation of static electricity by extremely rapid condensation of water vapor, due to the cooling of a rapidly rising column of highly heated air on an excessively warm day.

1. Explanation in theory: a gigantic electric spark current is set up when oppositely charged clouds, the charges of the upper and lower portions of the same cloud, or oppositely charged cloud and gound formation come into proximity. When, as evidence of this resulting lightning, the air in the path becomes greatly heated, expansion ending in powerful compression and culminating blow,

takes place, and thunder sounds as a result of collisions of multifarious returning air particles.

2. The following items about lightning should be held in mind:

   a. Lightning need not be feared if no foolish risks are taken. It rather should be appreciated as a remarkable phenomenon of nature.

   b. All superstitions about lightning should be discounted.

   c. Distance of lightning may be determined approximately by counting five seconds to the mile.

VIII. <u>Gathering of weather data and forecasting</u>.-- Weather data and predictions by the U. S. Weather Bureau are used by many organizations and businesses, including

A. these civil and military individuals and groups

1. Farmers, who wish to know of storms or dry spells beforehand, or of damaging frosts, high winds, best time to spray, and the like;
2. Airway pilots, to whom data on air pressure, clouds, fog, icing conditions, turbulence of air, visibility are of vital importance;
3. Sea captains, who must avoid or prepare for storms, or protect perishable shipments;

4. Merchants and shippers, who seek advisement on perishable shipments over land routes;
5. Insurance agencies, who must determine their rates of insurance against bad weather to outdoor carnivals, sporting events;
6. Military strategists, of land, sea, and air, who essay to use the weather as a weapon either for peace time maneuvers or bellicose war time strategems;
7. All persons desiring to plan out-door work or recreation, such as planning proper clothing for today's trip;
8. Snow removal departments of town or cities;
9. Election strategists, whose plans may be foiled if a bad storm prevents voters from arriving at the polls.

B. The U. S. Government, thru the Weather Bureau of the Department of Commerce, and to some extent the Department of Agriculture, spends over $3,000,000 each year to study and forecast the weather.

1. A vast system-network of teletype, telephone, and telegraph lines reports atmospheric conditions from over 300 stations. Data on ceilings, visibility, clouds, air pressure, temperature, wind direction and speed are relayed thruout the

country each hour of every day, with detailed synoptic maps being analyzed and forecasts made each six hours.

2. Upper air reports are received from many cities thruout the country, and this information, from pilot balloon runs, rabals, radiosonde, rawin, and radar is fully studies by both airplane pilots and forecasters.
3. Weather instruments fall into three categories: indicating, registering, and recording. The rain gauge registers amount of precipitation, and the "tipping bucket" guage records it. The nephoscope records amount and direction of clouds. The hygrograph records relative humidity, while the ceiling light and clinometer are used to ascertain cloud heights at night.

C. Weather reporting and forecasting are now worldwide activities, with impetus of World War II tremendously increasing the scope and potentiality of the service both for war and peace time extension.

Methods of
Introduction-Motivation

Foreword.-- It is proposed that the instructor choose the one alternative from the six listed for which materials are within his best facility.

Time allocation has been tentatively computed in minutes:

Part 1: 15
Part 2: 25
Part 3: 30
Part 4: 15
Part 5: 20
Part 6: 15.

In the interest of time economy and continuity of activity, no space is apportioned for a unit pre-test. The psychology of starting any undertaking with a test seems untenable. Motivation that has gained pupil interest should immediately lead to rolling up of sleeves and getting down to business on the first major topics.

Method one.-- Instructor passes out a small slip of paper to each pupil. The student writes the answer to question: "In December of 1944, which of the Allied military figures do you believe Germany and Japan would have preferred to lay their hands on, and squelch his work?" Instructor announces the findings and finds out the reason for their selections. Then he reads excerpt from the Readers Digest article of that month showing the tremendous price the Axis countries would put on the head of the most

successful of USAAF weather forecasters, whose success had played and was playing extremely great havoc with Japanese chances in Pacific battles, by using weather strategy to help lick the Nippons.... This should motivate a discussion of the part that weather played in World War II.

Method two.-- Teacher displays to class newspapers and magazines, or articles clipped therefrom, with pictorial matter describing as many items as obtainable of the following type:

A. New England hurricane of September, 1938.
B. Killing of fruit tree buds by late frost in spring.
C. November "Indian summer" results in resprouting and rebudding of flora.
D. Sunday newspaper supplement feature attacking some new study of a phase of weather or climate- such as a recent one on a study of dust over cities and its influence on weather, or a rotogravure section picturing a weather observer and a forecaster on the job at the Weather Bureau.
E. Hurricane disturbance and damage in Florida.
F. Accounts of the storm that almost ruined D-Day invasion of June 7, 1944. On June 19 a terrific wind storm ripped up one large pontoon bridge and greatly damaged another along the coast of France, the invaders using these bridges as supply highways. Had D-Day been attempted on this latter date, as was once contemplated, the attempted invasion might have proven the greatest disaster in history.
G. Typhoon in China is alleged to be cause of medicine black market.

Method three.-- Instructor shows these remarkable photos of clouds in an opaque projector:

A. Article "Toilers of the Air" in National Geographic Magazine, for August, 1925.
B. Sixteen photos of "Cloud Forms" to be procured from the Superintendent of Documents, Washington, D. C., for five cents. These pictures are posted in all Weather Bureau and Army Air Force weather stations.

Method four.-- Instructor shows to class and briefly explains functions and purposes of Rossby diagrams, aid given to forecasters by adiabatic and isentropic maps, synoptic maps, and winds aloft plottings. (These forms comprise unusual pieces of art, and, with their distinctive colors and designs, should readily attract student attention.)

Method five.-- Pupils are asked to name countries and portions of the world where their brothers or older acquaintances served in World War II. Instructor will then display a large colored map of the world, with the different climatic regions of the earth illustrated (map may be based on one in Ridgley and Ekblaw or other reliable geology or physiography text). Discussion of what service fellows had to say about the weather and climate of the southwest Pacific, China, Near East, France, etc., may follow. Do their descriptions agree with what the climate map says?

Method six.-- Instructor may carry out two or three of the demonstrations listed in either the delimitation of the paper or in the optional related activities section.

Core-Basic Activities

Foreword.-- Each required core activity is calculated to find a basis in both general and specific objectives set up by the writer when the unit was being activated. Thus, on the right hand side of each of the following pages, in column 1 the related general aim is referred to; in column 2 designation of related specific aim is made.

Attempt to systematically estimate duration of class-room work for each project (used in its wider sense) has been made. Ten 45-minute periods are assumed as probable time allotments for the whole unit, exclusive of the final test period. Column 3 contains time estimates in minutes. Symbol * indicates that the work is not intended for participation of the class as a whole; one or two students best suited for the particular work will attempt the job independently of the class. Symbol "aa" points to work to be done at home.

Activity	1	2	3
Temperature.--			
1. Experiments and demonstrations			
a. Place thermometer at different heights to show differentiation of temperature.	1[b]	IIB[b]	3[b]
b. Check boiling and freezing points of a thermometer.			3
c. With a tire pump show the warming of air by compression and cooling by expansion.			3
d. Measure extent to which a thermometer will rise when struck by light reflected from a mirror. Show difference between temperature measured in still air and that of air in motion.			3
e. Determine why one should always interpret readings in the shade rather than in the sun. Compare readings given by thermometers at the same time in the same place.			3
2. Construct a Galileo thermometer (see Richards Topical Encyclopedia, Vol. I, Page 213).	4	IIA2	*
3. Class members will each draw January and July isotherms on printed or traced world map for United States.	3	IIC	30
4. Maintain an hourly temperature record during school hours.	3	VIII B1	[c]*
Air pressure.--			
1. Each student will plot 25 representative synoptic stations thruout the United States, with emphasis on pressure readings.	7	VIII B1	30

b/ Three columns are interpreted thus: Demonstration 1.a. is based on general aim 1, and on specific aim IIB. Time estimated for activity is three minutes.

c*/ Indicates that activity is not intended for entire class.

Activity	1	2	3
2. Maintain an hourly record during the school day of atmospheric pressure, from aneroid barometer. If feasible, borrow a microbarograph chart from and compare with readings at the nearest Weather Bureau station. In cities such a record is often posted in public.	3	IIID	*
3. On printed blank maps of the United States draw and color a chart presenting a picture of the annual mean pressures for 25 to 30 stations distributed thruout the country. Divide the country into six or seven areas and make one written summarizing statement on the pressure tendency in each. Does altitude above sea level play a big role in your conclusions?	3	IIIE6	35
4. Study daily pressure trends as described in weather report columns and on weather maps appearing in newspapers. (For example, the map and pictogram in the Boston <u>Herald</u>, and the map and prose explanation in the New York <u>Times</u>.)	3	IIID	45
5. After class has fully covered material on pressure, a fact "spell-down" on pressure and temperature should be carried on for review purposes.	2	IIIA-E IIA, B	30
		Total	140

<u>Clouds</u>.--

Activity	1	2	3
1. Students will observe and study the Weather Bureau sound motion picture "Clouds" (see film bibliography, page 81). As alternative, use film slides, glass slides, or cloud photos in the opaque projector. Or the students may go outdoors to note the clouds actually present, as the instructor poses leading questions: How high are the clouds? Is there only one layer? Where do clouds "come from"? How do clouds now in the sky differ from those present on a stormy day?	1	VIA	15

Activity	1	2	3
2. Each member of the class will be furnished with a large, poster-size section of oak-tag, on which he will draw a cross section diagram of different types of clouds, their heights, general physical appearance, their relation to precipitation and storm types.	7	VIA	45
3. Display of pictures from the August, 1925, issue of the National Geographic Magazine. Should be a sine qua non. This may be accomplished on bulletin board or by means of opaque projector in a darkened room.	8	VI	*
4. Specified alternating pupils should maintain periodic, systematic cloud records on a prepared chart.	7	VI VIII B1	*
		Total	60

Precipitation and obstructions to vision.--

Activity	1	2	3
1. Motivation will be accomplished when teacher orally finds out and places on blackboard class consensus of factors, such as how much rain falls each year in Our Town, whether more water is realized from rain or from snow, how much fog we have and in which season of the year we experience the most fog, whether it is drier or warmer in Massachusetts than in Michigan or Montana, as expressed by a showing of raised hands. This should lead to the necessity of probing weather records to determinate who has been the nearest to correct. The students will have to consult compilations like the 1941 Weather and Climate volume of the Department of Agriculture, and the New York World-Telegram Almanac, an annual publication.	3	VII	20
2. Class will study Our Town precipitation records covering last ten years and make charts or diagrams or prose summaries describing rain, snow, hail, drizzle fall in the period.	3	VII B3	35

Activity	1	2	3
3. Instructor should select from the Yearbook one particular topic on precipitation or fog that appears to be of most importance at the time of year in which the unit is being taken up (e.g., snow or hail in winter and summer respectively). Students will each construct a bar graph or pie graph to make visual recording of the work or problem selected.	7	VIIB C, D	40
4. Simple evaporation and condensation demonstrations and experiments, in particular the use of the psychrometer should be included in the work. Relative humidity should be recorded regularly.	1	VIIA	15
		Total	110

Wind and wind storms.--

Activity	1	2	3
1. Introduction may be brought about by instructor's having pupils attempt to estimate the present wind spee. The teacher may confirm or disprove the different guesses by reference to the Beaufort scale system. Thus the pupils will be able to fairly acceptably note winds and their speeds for the rest of the unit, without the assistance of any mechanical wind measuring instrument.			
2. A collection from old and current magazines of articles and pictures describing damage wrought by hurricanes, tornadoes, typhoons, and other windstorms should be made for class use. Parents and older friends of the students have collected and retained considerable data on the New England hurricane of 1938, including snapshots they themselves took. A class discussion of pictorial matter in album or on a display table is essential.	2	IIIE	15
3. A simple project is the making of a weather vane (see Richard's Topical Encyclopedia, p. 48).	4	IV, V, B2	*

Activity	1	2	3
4. A completed winds aloft map may be shown to the students, and the wind directions and speeds noted and their characteristics pointed out.	7	VIII B2	10
5. Wind regions of the world are to be pasted, crayonned, or chalked in on a sphere or globe prior to class period, so that the explanation by the instructor will be less abstract than a text prose instruction.	2	IV, V A1-6	* 15
		Total	45

Weather Bureau and forecasting.--

1. Motivation effected by discussion of pivotal question: What good does the Weather Bureau do the United States? Why spend $$$ each year on a weather bureau? Teacher should have on hand several magazine and/or newspaper articles to supplement pupil opinion, and furnish evidence for settlement of any disagreements that may arise.	10	VIIIA	15
2. Each member of class is given a choice of listed topics several weeks before this weather unit is taken up. He selects one, then sends to the Superintendent of Documents, Washington, D.C., for literature on the subject. As an assignment for this unit he writes a summary of the article and passes it to the teacher for effort at evaluation.	4	Unspecified	••aa
3. One or two pupils should be assigned to check on accuracy of Weather Bureau forecasts, and almanac long range prognostications.	4	VIII B1	*
4. One literarily gifted student may write a skit on the history of weather forecasting in America. Duration: not over ten minutes. Roles may be read by class members.	7	VIII	15

••Symbol "aa" indicates an out-of-class assignment.

Activity	1	2	3
5. Audio-visual aid: instructor should write to film coordinator at U. S. Weather Bureau at Washington months in advance to find out what film he may borrow and when it will be available, or communicate with a nearby film lending library well in advance of the unit time. For this topic: "Weather Wizards," a ten minute, 16 mm., sound film. (See Bibliography, page 83.)	10	VIII	20
		Total	50 Minutes
		GRAND TOTAL	450 Minutes

Optional Related Activities

Foreword.-- Optional related work is enumerated by topics: air pressure; clouds; precipitation, condensation, evaporation; climate. After the instructor has decided which sections of activity may most benefit his particular group, he should suggest these projects ("projects" used here in a general way) to the students on individual duplicated sheets.

The list printed here, by no means original or exhaustive, has been synthesized from textbooks, workbooks, and published units.

Each exercise has been related to one of the broad aims around which the unit was built.

Weather and Climate, the yearbook of the Department of Agriculture for 1941, was carefully checked for work useful to a high school class in general science. The result appearing in this section may be mimeographed verbatim, or, in most instances, the instructor will want to make extraction at his own discretion.

These activities are not intended to be mandatory, as the term "optional" implies.

Air pressure.-- List of activities pertinent to the topic of air pressure follows:

(1) Climb a hill or small mountain near your home, carrying with you an aneroid barometer to determine the height of the summit of the hill. Keep

a record in a small notebook as you climb as to the exact decrease in pressure for each distance you climb. Remember that your findings will not be absolutely accurate without uniform conditions of temperature and pressure, by the accepted standard. (General aim 8)

(2) Visit a nearby Weather Bureau station and study the upper air pressure charts. Ask the forecaster why these maps are so important to him in making his weather predictions. Write a report of your visit and hand it to the teacher. (General aim 10)

(3) Construct a Swiss weather house barometer. See The Book of Popular Science, Volume I, Page 100. (General aim 4)

(4) Build a simple barometer in this way: extend a straw or a glass tube thru a cork stopper in a bottle, after you have burned a hole in the cork with a hot wire. Fill bottle one-quarter full of water. Allow straw to extend three-quarters inches below water. Pour melted wax around tube. Blow a long breath into the tube. (General aim 4)

(5) Find out why walls fall out of houses wrecked in certain Western windstorms. (General aim 9)

(6) Draw a map in color to represent high and low pressure areas, from your latest newspaper map. (General aim 7)

(7) Ask one of your friends or relatives who has a pressure cooker what its working principle is. Why is it often difficult to boil food in water at high altitudes? (General aim 1)

Clouds.-- Better understanding of clouds may be secured by pursual of these activities:

(1) Make a collection of pictures snapped above and between clouds. (General aim 4)

(2) Use water colors, pastels, chalk, or crayon to express your conception of picturesque cloud formations, which you actually observe. Draw a diagram of the "water cycle," as you may have the "nitrogen cycle" in biology. (General aim 8)

(3) If it is a warm day in spring, summer, or early fall, use this simple equation to find out the approximate height of the base of the cumulus clouds:

Height of base of clouds = $\frac{\text{dry bulb minus dew point}}{4.2}$ multiplied by 1000. (General aim 8)

(4) See E.O. Bower and E.P. Robinson, Dynamic Physics, San Francisco: Rand McNally and Co., 1942, for a systematic and concise chart on cloud types. Look on Page 360.

(5) Find out the differences between the meanings of the terms (1) pibal (2) rawin (3) rabal (4) radiosonde. How is radar used in collecting weather data. How is it used to overcome cloud difficulties experienced by airplanes? (General aim 6)

(6) Make a list of places in the world that are nearly always clouded over, and those that ever see but few clouds. How do the amounts compare with the averages of your home state or section? Hand the comparison in writing to your teacher for his inspection. (General aim 5)

Precipitation, condensation, evaporation.-- Continuation of listing of optional-related work is made:

(1) To make a simple rain guage, see Richard's Topical Encyclopedia, Volume XIV, Page 48. (General aim 4)

(2) To show the effect of evaporation, compare and contrast the amount of water that vaporizes from a container left in the sun to one that remains in the shade, or with its cover on in the shade--all over a period of time. (General aim 1)

(3) Find evidence to discredit the old superstition that lightning never strikes twice in the same place. Newspapers in the summer months frequently run articles telling of a particular building struck two or more times by lightning. (General aim 9)

(4) Make your own psychrometer by attaching two dry-bulb thermometers to a wood or metal clamp, with a small piece of muslin tied around the bottom of one of the thermometers. Wet the muslin with water and then sling or whirl. (General aim 8)

(5) If it is winter, apportion one section of snow for measurement and record to the nearest tenth of an inch immediately after the fall of each snow. Also, record depth once daily (just before school begins in the morning, for example). (General aim 10)

(6) Collect and melt snow to determine the ratio of snow to rain in the amount of water contained in the snow. Will different types of snow have different moisture content? (General aim 3)

(7) A small amount of fog may be formed by placing a dish of hot water where escaping cool air from an inflated tire passes over it. (General aim 8)

(8) To produce condensation, blow on a cold window; place a pitcher of cold water in a warm room; temperature of the dew point is found by putting thermometer up for reading when the water begins to cloud the surface of the pitcher. (General aim 2)

(9) Smoke control in a large city is said to lessen the amount of fog. Explain. (General aim 6)

(10) Draw a bar graph or pie graph to pictorialize the amount of precipitation recorded in your town for each month for the past five years. (General aim 3)

(11) Consult U. S. Army Technical Manual 1-235, at a city library, to find out the exact measurement limitations of certain types of precipitation. (General aim 1)

Climate.-- Supplementary work in climate may take in one or more of these activities:

(1) Keep a class scrapbook of newspaper, magazine clippings, postal cards, and other photographs of the main climatic regions. By giving one

section to a particular region, the peculiar traits of the area will be graphically portrayed. (General aim 7)

(2) Make an oral report to the class on climatic conditions which geologists believe existed in pre-historic eras and geologic periods, in the New England area, for example. (General aim 3)

(3) Contrast the life of the Eskimo and that of a native of central Africa, and show how climate plays a great role in determining the ways of life. (General aim 6)

(4) Explain these terms: corona, halo, St. Elmo's fire, virga, front, Chinook, monsoon, "mock sun". (General aim 2)

(5) Form an observers' and forecasters' club. (General aim 5)

Suggested uses for the 1941 Yearbook of the Department of Agriculture, Weather and Climate.-- I. "Climatic Changes thru the Ages": A. Using material on Page 104 as a guide, make a colored map of the principal world climates. B. Draw a hypothetical world rainfall map from data on Page 101. C. Construct a large chart on cardboard in schematic representations of distributions of (1) climatic (2) vegetative (3) major zonal soil groups on a climatic basis, Page 113. II. "The How and Why of Weather Knowledge": A. Draw sketches of and label parts of weather instruments. B. State what goes on in each picture on Page 136. C. How many voluntary verified collectors of weather data are there in the United States? Which state has the most? Per unit area? Make estimates for your answers. Count dots if class fails to agree. See Page 141. D. Make a table by states to show the extent of (1) corn and wheat crop weather service (2) cotton crop weather service (3) citrus fruits weather service, on Page 145.

III. "Climate and Agricultural Settlement": A. Imagine yourself an early settler in New England, Pennsylvania, or Virginia. Use Pages 158-166 for your source material to write a diary of what you saw about the climate when you first arrived from the Old World. You may: (1) contrast American and European brands of vegetation (2) describe Indian agriculture and agriculture in the Northern colonies

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(3) list contributions of middle colonies to American agriculture (4) describe the climate of the sub-humid mid-West and that of the great plains area.

B. Select two of your favorite states and make colored maps to show climatic distribution pattern in 1905, 1910, and in 1934. Divide the state into sections. See Page 182.

IV. "Climate and Settlement of Arid Regions": A. Summarize valley and mountain precipitation by months at Yakima, Salt Lake City, and Phoenix. Consult Page 191. B. How do mountains influence rainfall? See Page 192.

V. "Climate and Future Settlement": Construct two maps: (1) population concentration of the earth, as compared with (2) climates favorable to settlement. See Pages 229, 230.

VI. "Health in Tropical Climates": What does the diagram on Page 249 on conditions of comfort in dry bulb and wet bulb temperature ratio mean to you?

VII. "Climate and the Farmer": A. From Pages 277-278 select a section of the country and color a map for the types of soil characteristic thereof. Or make a broad association of great soil groups, using the Page 278 map as a model.

B. How many climatic disadvantages be overcome by breeding of cattle? Analyze diagrams on Page 512.

VIII. "Flood Hazards and Flood Control": A. Make a card-board diagram of the hydrologic cycle according to modern meteorological evidence. Refer to Page 535. B. Follow the

hourly progress of rainy weather over the lower mid-West and the mid-Atlantic states on January 20, 1937, on Page 556. C. On Page 567, make a summary of the estimated flood losses in the United States. Do this either in prose or by means of a map.

IX. "How the Daily Forecast Is Made": A. Consult upper air chart, Page 590, at 10,000 feet. How does the pressure of the air compare with that at the earth's surface? B. Have your teacher explain to you the two storm cross sections on Page 594. C. How would temperature increase with altitude if radiation alone controlled the atmosphere? See diagram on Page 603. D. If the earth did not rotate, what kind of weather would we have if the sun's heat were applied evenly everywhere? E. Refer to diagrams on Pages 607 and 611 to discover the reasons for different wind belts.

F. Make use in a way suggested by yourself one of the following: pressure profile for the Northern Hemisphere, Page 612; millibar distribution maps, 612, 614, 615, 624, etc.; temperature maps of the United States, 630, 631, 638; isentropic, 642, 644, 649, 651.

X. "Forecasting from Cloud Formations": A. Read the article by G. C. Rossby on Page 657; then try to put into practice some of his suggestions. Report on your success or failure.

XI. "Climates of the World": A. Map showing distribution of precipitation over the earth may be studied on Page 668. B. Read 672-684 containing temperature and precipitation data for representative stations on a world wide distribution, by months. C. Do not fail to study the long term trends in precipitation data for representative stations on a world wide distribution, by monthly statement.

XII. "Climates of the United States": A. There are 46 maps (Pages 702-747) containing information on such topics as

(1) annual maximum temperature
(2) annual minimum temperature
(3) average annual precipitation
(4) average summer and winter precipitation
(5) average annual snowfall
(6) average number of days with snowfall, hail, and snow cover
(7) data on average relative humidity
(8) number of days with dense fog
(9) percentage of possible sunshine, summer and winter
(10) depth of frost penetration
(11) miscellaneous other data

B. Pages 750-1225 cover all states and territories of the United States, Giving data in reference to county, station, temperature length of record, killing frost dates, average monthly precipitation. A two-page prose description follows each map and table .

Test Material

Foreword.-- The matter in this section is intended for a final written examination, to which all of the final 45 minute period of the unit will be devoted. The result will be partly one of the so-called "objective" type answers in (1) matching statements with diagram, and (2) fill-in declarations. To determine how well the student is able to organize his thinking in clear cut English, one of the problems of the "prose," "subjective," or "long answer variety" will be used. Estimated time is 20 minutes.

Matching statements with diagram.-- Both statements and diagram should be duplicated (or a large master copy diagram placed at the front of the room) for each student.

TO THE STUDENT: In the sketch on Page 69 we observe a small section of scenery in our Prevailing Westerlies region. To the left or west appears a large body of water- a West coast ocean shore line. In the center of the picture is a mountain that towers to slightly over 9,000 feet above sea level. Directly to the east of it lies a valley. To the very right or east is our final feature- that of another mountain. This latter mountain ascends to about 6,500 feet in height above sea level...Choose the region of the diagram which best applies to the particular statement on the prose paper. Statement 1 has been filled in as an example...Before the test begins examine the diagram carefully, and ask the instructor to explain any point not clear in your mind.

The statements enumerated.--

(1) A "land breeze" blows from region_1_to region_2_.

(2) Most of the fog forming over a land area will be found in region___.

(3) More ground fog will occur in region___than any other region.

(4) A night sea breeze in summer is likely to blow from region___to region___.

(5) Stratus clouds over land will form in region___or in region___.

(6) Altostratus clouds over water will form in region___.

(7) The tropopause would be located in region___.

(8) Ninety-eight per cent (98%) of the earth's atmosphere is found below region___.

(9) Cirrus are found in region___.

(10) A low cloud laying a protective blanket over region___ would protect agricultural products or plants from damage by frost.

(11) The highest point of a cumulonimbus cloud may reach to the upper altitudes of region___.

(12) If the pressure at sea level is 30.00 inches, it will approximate, under standard conditions, 23.00 barometer inches at the top of sea region.___

(13) Air pressure is least or lowest in region___over land.

(14) If this were a tropical part of the world, a hurricane would do most damage to ship or building over region___, providing the storm were just forming.

(15) Land region likely to receive least precipitation is region___.

(16) Air reaches its greatest density over sea region___.

(17) Ocean air commencing to rise from near sea level will have to lose its greatest amount of moisture over land region___.

(18) A halo resulting from refracting of light waves occurs in region___over water.

(19) The water cycle must include region___.

(20) The highest stratosphere balloon, with man in the spherical car as passenger, ascended into region___at its greatest point of climb.

(21) It would be most hazardous for a pilot to fly in region ___in case stratus, stratocumulus, or fog were present.

(22) In region___a calm wind prevails.

(23) Hail may be formed over land or sea as high as region___.

(24) If the temperature is 90 degrees F. at the surface of the sea, it will be near -16 degrees F. at the top of area ___. (Assume the standard dry lapse rate.)

(25) The highest region reached by pilot balloons over land is area___.

(26) Short wave radio waves are reflected back toward the earth in region___.

(27) General lowness of temperature will greatly hinder growth of trees or other vegetation in region___.

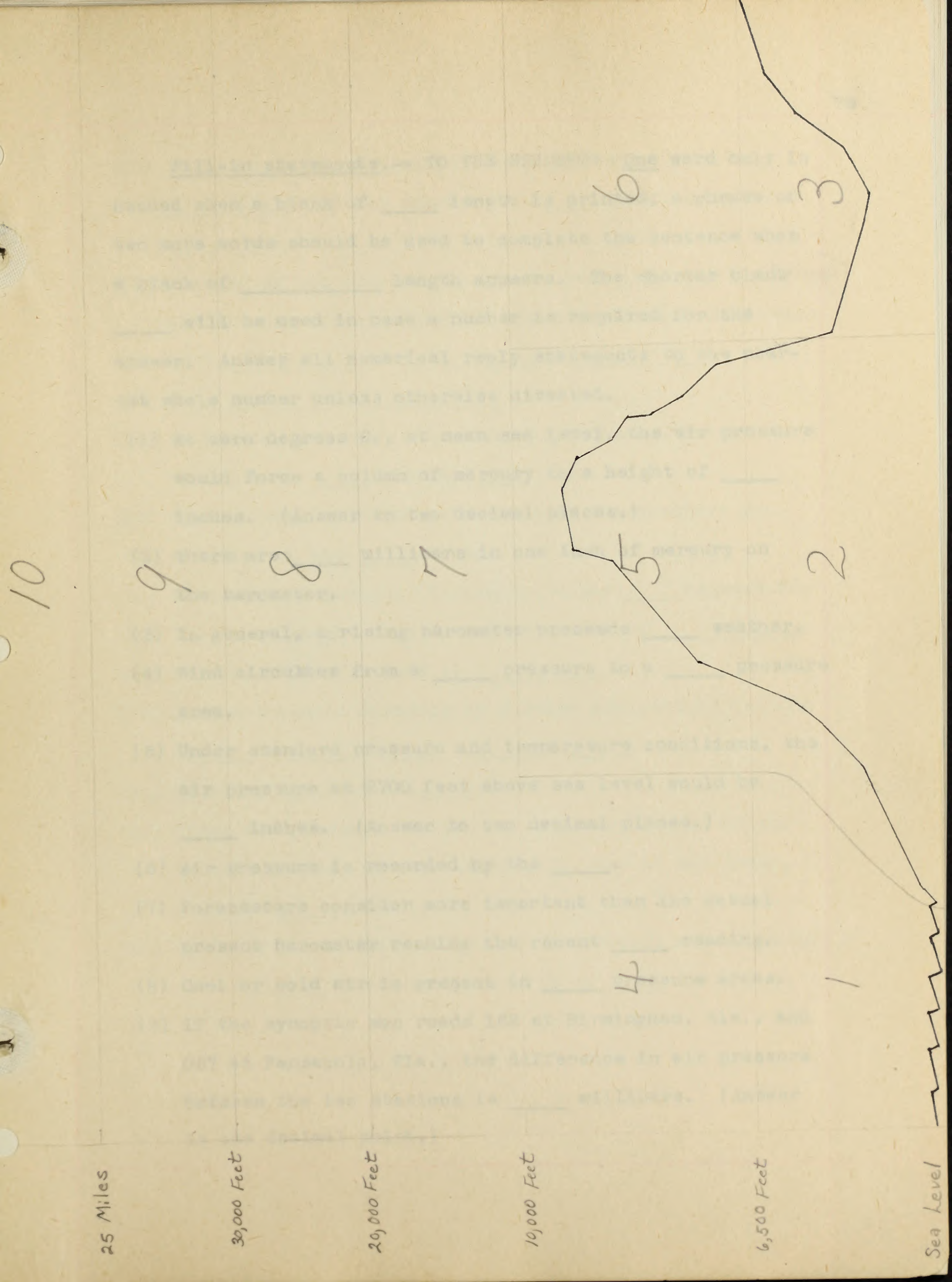
(28) A cloud layer at the bottom of region___would cause a Naval aircraft pilot to report "Ceiling zero!"

(29) A typhoon would cause most damage over region___, under 6,500 feet.

(30) The most luxuriant forest tree growth would take place in region___.

(31) Air pressure in the lowest three regions is greatest in region___.

(32) Most evaporation, comparatively speaking, will take place in region___.



25 Miles
30,000 Feet
20,000 Feet
10,000 Feet
6,500 Feet
Sea Level
1
2
3
4
5
6
7
8
9
10

<u>Fill-in statements</u>.-- TO THE STUDENT: <u>One</u> word only is needed when a blank of ____ length is printed; a phrase of two more words should be used to complete the sentence when a blank of __________ length appears. The shorter blank ____ will be used in case a number is required for the answer. Answer all numerical reply statements to the nearest whole number unless otherwise directed.

(1) At zero degrees C., at mean sea level, the air pressure would force a column of mercury to a height of ____ inches. (Answer to two decimal places.)

(2) There are ____ millibars in one inch of mercury on the barometer.

(3) In general, a rising barometer preceeds ____ weather.

(4) Wind circulates from a ____ pressure to a ____ pressure area.

(5) Under standard pressure and temperature conditions, the air pressure at 2700 feet above sea level would be ____ inches. (Answer to two decimal places.)

(6) Air pressure is recorded by the ____.

(7) Forecasters consider more important than the actual present barometer reading the recent ____ reading.

(8) Cool or cold air is present in ____ pressure areas.

(9) If the synoptic map reads 162 at Birmingham, Ala., and 057 at Pensacola, Fla., the difference in air pressure between the two stations is ____ millibars. (Answer to one decimal point.)

(10) Storm areas in the United States generally move from ____ (point of the compass) to ____ (another point of the compass).

(11) History of the changes of climate over geological periods and in more recent historical times is studied thru means of 1.__________ 2.__________ 3.__________ 4.__________ 5.__________.

(12) In heating a house it is necessary to make provision for mixing both ____ air and ____ air.

(13) The maximum and minimum temperature thermometers are examples of the ____ type.

(14) Mercurial thermometer is useless below ____degrees F.

(15) The thermograph works on the principle of __________.

(16) Climate may be defined as __________.

(17) Diseases caused directly by climate and weather include 1.____ 2.____ 3.____ 4.____ 5.____.

(18) Relative humidity is ____.

(19) Total air pressure exerted on 16 square inches of the earth's surface at zero degrees C., and at sea level, would be ____ pounds.

(20) Cyclonic storms in the Northern Hemisphere move from an area of ____ pressure to an area of ____ pressure.

Long answer problems.-- These "long answer", "prose", "subjective", or "essay" type problems are aimed to determine how well students can organize information around one central topic or theme. One or possibly two (if the class period is 60 minutes) of the following may be selected for use along with the short answer variety of statement.

(1) Summarize briefly the effects that tornadoes, hurricanes, thunderstorms, have had on farm crops and building property in our country in the last ten years.

(2) Draw a diagram of the earth and its wind belts. Make one or two sentence statements that will explain the typical atmospheric conditions prevailing in each region.

(3) Outline the three types of weather instruments and describe the functions of three instruments in each class.

(4) List five ways in which the Weather Bureau helps either the farmer, industry, or the public as a whole.

(5) Draw a diagram showing the three major types of clouds. Label the specific types of clouds as you place each in its proper altitude position.

(6) Compare and contrast workings of the aneroid barometer, the altimeter, and the mercurial barometer in relation to (a) function or purpose (b) structure.

(7) Define in one or two complete statements: front, high, isobar, relative humidity, pilot balloon, hurricane, "Horse Latitude", Prevailing Westerly.

(8) Outline six outstanding events in world history which were influenced directly by weather conditions.

(9) Explain five different factors of geography that influence climate or weather in New England.

Key to test problems.--

DIAGRAM AND MATCHING STATEMENTS:

1. 1...2
2. 2
3. 3
4. 2...1
5. 2...3
6. 7
7. 9
8. 9
9. 8
10. 3
11. 8
12. 1
13. 10
14. 1
15. 1
16. 3
17. 5
18. 8
19. 1
20. 9
21. 2
22. 3
23. 8
24. 7
25. 9
26. 10
27. 5
28. 1
29. 1
30. 2
31. 1
32. 1

FILL-IN STATEMENTS:

1. 29.92
2. approximately 34
3. fair, good
4. high...low
5. 26.92
6. barograph or microbarograph
7. trend, tendency
8. high
9. 10.5
10. west...east
11. (1) tree annual layer growth (2) sun spots (3) deposition of soil (4) volcanic material and river deposits (5) glacial action
12. warm...cold
13. registering
14. -39 degrees F.
15. a metal tube, which expands and contracts with a change in temperature
16. average condition of the weather at a place, over a period of years, as shown by temperature, pressure, wind velocity, precipitation, etc.
17. heatstroke, snowblindedness, frostbite, mountainsickness.
18. the ratio of the amount of water vapor present in the air compared with the amount of water vapor the air could conceivably hold at the present temperature.
19. 235.20
20. high...low

Visual Aids

Foreword.-- Visual aids may be placed in the categories of (1) school journey (2) museum study (3) objects (4) models (5) moving pictures (6) still pictures.

The goal is the providing of pupils with experience with concrete material- a more vivid background to be used in abstract thinking.

With reference to the dividions of paragraph one, in this weather-climate unit the instructor may

(1) Not contemplate a school journey for the class as a unit. It is hardly feasible to take an entire class group into a weather station as a whole. However, the teacher should encourage such visitation by individual pupils outside of school time, when and where visitors are allowed.

(2) Not find the museum of natural history, science, industry, or related subject of much assistance in this unit. An exception to this statement, for example, is the city museum at Worcester, Mass., where a student weather station is maintained.

(3) Use the object to advantage. Pupil construction of simple weather instruments is recommended in both core and optional related sections of this unit.

(4) Discover no models of any value to this unit.

(5) Use the following suggestions[1] for good use of films of the factual type:

(a) Order film well in advance, and make sure to get it when the subject matter is being taught.

(b) Preview the film and make note of content.

(c) Decide what portions of the film should be grasped by the pupils.

(d) Prepare class with needed vocabulary.

(e) Give class a list of directing questions.

(f) After the picture has been shown, make opportunity for discussion of film and/or an assignment for further study of the subject matter.

(g) Test to see how much the film has taught.

From another source[2] comes an outline of methodology of points and factors for teacher consideration:

(a) Analysis of film content.

(b) Evaluation of the film-relation to the unit (titles, sequence, accuracy, effect on attitudes, quality of photography).

(c) Pupil motivation and preparation (eagerness for content, awareness of aspect, knowledge of organization, understanding of contents).

1/ Recommended by Dr. Abraham Krasker, of Boston University, in his visual aids class.

2/ Charles F. Hoban, Charles F. Hoban, Jr., and Samuel B. Zisman, Visualizing the Curriculum. Dryden Press, New York, 1946, p. 93ff.

(d) Method of projection.

(e) Inducing of generalization.

(f) Checking pupil observation.

(g) Integration with other materials of a visual aid character.

Sound films for unit in weather-(Wilson catalog,[1] Dewey 551.5)

1. "Aerology: Ice Formation on Aircraft"
   Part I: How and Where Ice Forms
   Part II: Review

   This 48- minute film shows processes of ice formation, effects of ice on aircraft, and explains how wing ice, ice in the pilot tube, and ice on the propeller and ice in the carburetor become flying hazards. Instructor of high school science will find much of these reels overly technical and in too much detail for his purposes, so that considerable culling will become necessary.

2. "Aerology: Thunderstorms"
   A 41-minute long picture deals with the formation of thunderclouds; it points out their identifying features and discusses alternatives a pilot may follow when storms are encountered, and dramatizes one pilot's experiences with a thunderstorm.

3. "Clouds" is an 11 minute, 16 mm., sound film pertaining to such topics as types of clouds and movements of highs and lows. Weather forecasting as the result of cloud study is described. This picture is of Weather Bureau origin.

4. "Clouds and Weather" provides 16 mm. film of six minute duration, and gives an explanation of changes in weather and clouds.

1/ Educational Film Guide, H.W. Wilson Co., New York, 1946.

5. "Flood Weather" is described as a film of 16 mm. variety, with a 45 minute time stretch in material on the weather forecasting for river navigation and flood protection.
6. "Fair Weather Clouds" is part of the Bruce instructional series, and is a one reel, 16 mm., silent film, dealing with weather forecasting for river navigation and flood protection, and presenting scenes of the Ohio and Potomac floods, a series of pictures of cloud formations of various types of cloud formations, with partial explanation in prose accompaniment.
7. "Foul Weather Clouds" is a one reel, 16 mm., silent film with striking pictures of the clouds that bring poor weather. The levels at which the various types of clouds are to be found, and the weather that usually accompanies them are explained.
8. "Modern Weather Theories and Structures of a Storm" includes (1) Part I: Primary Circulation, a 16 mm., Castle film. This section is concerned with the atmosphere that creates the prevailing winds, in addition to the principle of the air currents that are created by the tropical regions and polar regions in explanation. Illustration of how air masses veer in the two hemispheres and how they act at the Equator. Zones of the prevailing westerlies, trade winds, way in which warm, moist air evolves and similar topics are taken up. (2) Part II is Development of Atmospheric Waves.

9. "Weather" is a 10 minute, 16 mm., 1932 Erpi film concerned with the Polar Front theory and describes weather instruments and ways of cloud formation. An explanation in general of the science of meteorology is made.

10. "Weather Wizards," a 10 minute, 16 mm., sound, Encyclopedia Britannica film, is concerned with the Weather Bureau and its apparatus, and brings out the value of the Weather Bureau to agriculture, with the California citrus fruit industry as the particular example.

Kodachrome Slides for Weather Unit Visual Aids.--

1. Altocumulus slides: Bm 38, 55, 65, 73, 83, 72
2. Altostratus slide: Bm 54
3. Thunderstorm slides: Bm 42, 43
4. Cirrus: 7, 8, 9, 84
5. Cirrostratus: 12, 36, 71, 82
6. Condensation: 89
7. Cumulus: 1, 2, 10, 44, 57, 58, 75, 77, 81, 80
8. Fractocumulus: 11
9. Ghost or mock sun: 87
10. Storm clouds: 47, 48, 49
11. Nimbostratus: 40, 53
12. Stratocumulus: 3, 4, 5, 59, 60, 66, 68, 70
13. Stratus: 39
14. Weather instruments: anemometer, 13; sunshine recorder, 14; aneroid barograph, 15; rain guage, 17; hygrograph, 21; instrument shelter, 25; mercurial barometer, 22; portable weather station, 28; radiosonde receiver and recorder, 23;
15. Weather instruments and scenes in and about a weather station: 13, 14, 15, 17, 21, 24, 25, 27, 28, 29, 30, 31, 32, 33. (N.B., Complete, latest list may be secured from the nearest visual aid dealer, or by writing to the Society for Visual Education, Inc., 100 East Ohio Street, Chicago, Ill. These slides are made by Eastman Kodak Company, Rochester 4, New York.)

List of Weather-Climate Glass Slides Made by the Keystone View Co., Meadville, Pennsylvania

Catalog Number	Title	Content
161	Sun Spots	Prof. Abbott looks thru a spectroscope; close-up view of the sun; distant view of sun spots.
162	Weather "Spots" of the World	Hottest, coldest, wettest, driest, snowiest, sunniest, cloudiest, calmest sections of the world are pointed out.
163	Weather "Spots" of the United States	U.S. is divided into regions, such as hottest, coldest, most snowy, mildest, etc.
164	Winds the Wanderers	Effect of wind on vegetation; four different style weather vanes.
165	Winds on High	The taking of a pilot balloon run; plotting; theodolite.
166	The Terrible Tornado	Four views of the tornado and the water spout.
167	Nature's Javelin-Lightning	Photos of lightning striking trees and water.
168	Earth's Gray Blanket	Three fog illustrations; one aerial view.
169	Clouds and Their Forms	Photographs of cirrus stratus, nimbus, and cumulus clouds.
170	Queer Rains	Traditional legends of what has fallen from the sky.
171	Nature's Jewels	Study of frost formations on plants.
172	Bullets of Nature	Photographs of some of the largest hailstones ever recorded.

Catalog Number	Title	Content
173	Snow the Most Beautiful	Thirteen patterns of snow crystals.
174	Snow in the United States	A snow thrower; snow measuring instrument ice cutter vessel.
175	Sleet and Glaze	Six examples of sleet formation.
176	Indoor Weather	Relationship of health to temperature, in cartoon presentation.
177	Instruments of the Weather Bureau	Photos of six instruments; weather tower; instrument shelter.
178	What Will the Weather Be?	Weather Bureau at work; an interior scene.
179	Weather Lore	Sky conditions photographed.
180	Noted Weather Scientists	Photos of Franklin, Ferrell, Shaw, and Humphries.

CHAPTER III

UNIT ORGANIZATION IN PHYSIOGRAPHY

General Aims

Foreword.-- Methods of origin of these broad objectives are almost identical with those of the previous unit in weather. The goals set up are high ones, although endeavor has been made to keep to a path of sensible possibility of realization. Further difficulty will be found in the attempt to measure progress made in the designated directions. Aim 8, for example, presents items that tend to defy objective measurement, even under the best of conditions.

Statement of the aims.-- Work in this unit should

(1) motivate interests of the students so that they will want to find out more of the nature of the formation of, and other characteristics of mountains, rivers, glaciers, volcanoes, earthquakes, and similar phenomena in the balance of their high school courses as well as later in adult life;

(2) enable the students to gain introduction to the basic principles of physiography enumerated in the delimitation of this paper, commensurate with the amount of school time spent on the material;

(3) promote student interest especially in the students' home town about the science, and a general curiosity about the physiographic features of New England in a wider view;

(4) provide for individual differences, by planning for assignments in proportion to students' individual abilities and needs, and by suggesting optional activities;

(5) motivate each student to work on at least one type of creative project, which he will take from the course as material accomplishment;

(6) show the student the close relationship between physiography, weather, climate, commerce, industry, history, and other important phases of life;

(7) suggest to the student the possibility and desirability of collecting of minerals, or of other further study of the science as a worthwhile hobby (study of physiography in connection with the present hobby of photography, for example);

(8) increase the facility of the student in the use of reference books, indexes, summarizing, chart reading and map making;

(9) increase student appreciation of the fact that all physiographic conditions of our earth to-day were brought about by action controlled by laws of nature;

(10) promote the desire of the student to see the topographic beauties of America for himself, even if it will be possible for him in the foreseeable future to do so in a vicarious way only.

Delimitation

I. The earth and its formation.-- Even as breathing, fire, decay, diffusion of light, heat, sound waves, winds, rain, waves, and other phenomena of nature are dependent on the atmosphere surrounding the earth, the earth makes, in its turn, man its dependent by furnishing him a home. From the soil mantle grow food plants and all other types of vegetation that man utilizes. Beneath lies bed rock, from which many commercially valuable mineral substances are secured.

A. According to the Nebular Hypothesis, a great globular mass of hot gas, a nebula, cooled gradually. Scientists favoring the Planetismal Hypothesis maintain that a spiral nebula consisting of manifold cold particles was in time collected by collision and gravitation to make up the sun and later the planets.

B. The interior of the earth is believed to be an extremely warm solid. The earth's surface itself has been roughened by influence of shrinkage of the heated interior.

1. The result has been continental elevations and oceanic basins, on both of which are located mountain chains, and volcanoes.

2. Average depth of the ocean is about five times the mean height of the land above sea level. Loftiest mountains on earth tower approximately as high as

lowest ocean bottoms descend below the surface of the water, or a total distance of about 11 miles.

II. Denudation.-- Agencies of denudation (such as weather, rivers, glaciers, sea waves) are constantly in process of cutting into the land and strewing the waste over the sea floor.

A. In recent geologic times forces of elevation have been more powerful than forces of denudation.

B. Elevation, surface features, and coast lines of continents have had wide-spread affect on mankind, plants and animals.

C. Continual erosion results in decreasing the average density of continental masses and continual deposition in increasing the average density of rocks under the ocean.

D. The earth's surface is slowly being worn down in numerous places, but is in process of being built up in others. Prevalence of sedimentary rock is indicative of recent geological rising of the continents.

E. Rate of erosion is inversely proportional to the resistance of rocks to decomposition and disintegration.

F. The natural movement of particles which have been eroded is due chiefly to gravity and the rotation of the earth.

III. Types of rocks.-- Geologists call the earth, other than the atmosphere and bodies of water, the "lithosphere". Mineral formations are usually classified in three types of rocks in which they are to be found: igneous, sedimentary, and metamorphic.

A. Igneous rocks are formed as the result of cooling of molten rock, some at the surface of the earth in the form of lava, and some underground in form of dikes, sheets, bosses, and batholiths. Granite is an example of an igneous rock.

B. Sedimentary are layered rocks, or strata rocks, formed by or from deposits of sediment, especially (1) of fragments or of other rock transported from their sources and deposited in water, as sandstone and shale; (2) by precipitation from solution, as rock salt and gypsum; (3) from calcareous remains of organisms, as limestone.

C. Metamorphic rocks are any rocks on which pronounced change has been effected by pressure, heat, and water, resulting in a more compact and crystalline structure.

IV. Plains, plateaus, and deserts.-- Among the more prominent physiographic features of the earth are

A. Continental plains or shelves made up of millions of clay particles sediment from the land, buoyed up by the ocean water. Vast plains, caused by recent uplift of ancient sea bottoms, extend over a large part of Northern Africa, Europe, and a portion of North America.

B. Plateaus, which are elevated plains, raised during mountain uplift, and less vulnerable to wearing down than low land plains. Plateaus are often arid and relatively cool.

C. Deserts comprise plains or plateaus reduced by denudation to the point of extreme sandiness. Deserts can support little or no life because of temperature extremes and lack of water. However, they sometimes support mineral extraction and production.

V. Mountains.-- Mountains occur on continents where they form chains of islands, peninsulas, and systems which rise at the very margin of the land. They also form chains in the open ocean.

A. Mountains have been formed by distortion, breaking and upheaval of the earth's crust, by forces originating in, or determined by interior conditions of the earth. Folding of rocks is one of the chief ways in which mountains build up.

B. Types of mountains include simple folded block mountains, lacolith and domed mountains raised by lava intrusion, evenly folded mountains, and completely folded and faulted mountains.

C. Young mountains are rugged; mature mountains have been lowered and the valleys broadened. Old mountains may be lowered to the peneplain extent.

D. Mountains are poor in population, weather, and agriculture; but they may be conducive to tourist recreation particularly in summer. Mineral and waterpower advantages often are found in mountain regions.

VI. <u>Glaciers and the glacial period</u>.-- The term glacier refers to a field or body of ice, formed in a region where snowfall exceeds melting, and moving slowly down a mountain slope or valley, as in the Alps, or over a wide area, as in Greenland.

A. Glacial conditions are as a rule approached by increasing latitudes or altitudes.

B. When a valley glacier is being made, snow derived from the snowfield, changes to granular ice (called névé), then to ice, which extends down the valley as an ice tongue.

1. As the glacier moves, it plucks and scours its bed, and carries rock fragments both on its surface (lateral and medial moraines) and its groundward section (ground moraine).
2. Rock fragments fall thru crevices to the bottom, and assist the ice in erosion.
3. Terminal moraines are built at the ice front.

C. Striae, erratics, evidences of erosion, moraines, and the like, indicate that great continental glaciers, or ice sheets, formerly covered northeastern North America

and northwestern Europe. Evidence suggests that two advances and two retreats of the great glaciers occurred.

VII. Rivers and valleys.-- In arid lands, and where the forest has been removed, the land is sometimes so gullied by rain sculptoring as to unfit the land for agriculture. This is where the farmer may bring irrigation into play. A river or its resevoir is likely to furnish the water supply.

A. Streams, generally, are lowering the surface land in some places and building it up in other places. As a river cuts vetically on its bed, the rate of wearing-away varies with the rock, slope, volume, and sediment supply. Some rivers are deep with onrushing current that tends to wear down the banks rapidly, while other streams prove slow and sluggish, with little power of denudation.

B. Streams lengthen their valleys, in many cases, by extension of rain gullies into the divide areas.

C. Falls and rapids, of use for water power, are common where a degrading stream flows from strong to weak rocks, as at Niagara. Falls or rapids tend to develop in a stream bed where the stream flows over a hard stratum to a soft one.

D. River valleys are classified as old, mature, and young, as determined by how much erosion, weathering, and denudation have taken place.

E. A delta is a level plain, built up by the deposit of sediment at a river mouth. It is commonly triangular in shape, due to crossing by branching tributaries.

F. Alluvial fans are triangular in outline like deltas, and are built up where streams descend from steep to gentle slopes, as at the base of mountains. The lower slopes of large alluvial fans are important agricultural lands.

VIII. Volcanoes, earthquakes, and geysers.-- Expanding steam and other gases are responsible for explosive volcanic eruptions. Lava eruptions come from low resevoirs of molten rock material situated at no great depth below the surface of the earth.

A. Earthquakes result from movement and vibrations of rocks of the earth's crust. Faulting and volcanic action are frequently responsible for earthquakes. Thus one sees that forces within the earth may cause breaks in the earth's crust. Earthquakes are recorded on seismographs, often a great distance in miles from the site of the disturbance.

B. Surface water, percolating underground and coming in contact with hot lavas in volcanic regions, is heated and erupted, forming a geyser.

IX. Physiography of New England.-- New England is a region of worn-down, ancient mountains, with hill tops rising to a fairly even skyline, but with peaks and groups

of peaks rising above this level, especially in west and northern sections. Many of the mountain summits are still forest covered.

A. Agriculture is hampered by the action of the ice sheet in leaving a bouldery, glacier soil, together with prevailing hilly topography.

B. Only mineral wealth is building stone.

C. Water power, due to glacial interferences with streams, has encouraged the development of manufacturing.

   1. Sinking of the land along the coast has provided deep harbors for commerce.
   2. The irregularity of coast line is favorable to fishing and navigation.
   3. Soil is too thin, rocky, or sandy for cultivation in many areas for optimum agricultural use.
   4. The physiography of New England has several similarities to that of England and Scandinavia.

Methods for Introduction-Motivation

Description of alternative methods to be used to introduce the unit.-- One of the following activities for initial unit work may be utilized. Time estimation follows each.

(1) Instructor has taken photos of scenes illustrating various phases of geology and physiography, and brings these to class to build up interest and discussion by the pupils. Commercially prepared glass slides or home made photographic slides are excellent for the purpose, or photographs may be inserted in an opaque projector. Many of the more recent college physiography or geology texts contain a splendid collection of noteworthy photographs for use in the opaque projector device. (20 minutes)

(2) A commercially made up box with 12 to 40 small samples of common minerals is brought to class by instructor. He may show pupils how to match these samples with minerals seen in everyday rocks in the school locality. Question as to how the minerals were formed may be introduced at this point. (15 minutes)

(3) Several students volunteer to draw on the blackboard their own notions of what the outlines of a mountain, volcanic crater, plateau, butte, and so forth. These sketches may be compared for accuracy with actual photographs found in National Geographic Magazine, encyclopedia, or text-book. (15 minutes)

(4) Instructor carries on a sort of "Gallup Poll" inquiry to secure class opinion as to facts such as: the highest mountain in the world, in the United States; deepest portions of world oceans; time needed to carve out Grand Canyon to present extent; causes of earthquakes, volcanoes, geysers. (20 minutes)

(5) A sound motion picture, if obtainable on the proper date, may be planned for by instructor, and procedure set down in visual aid section carried out. Select one of the following three: (1) "Mountain Building" (2) "Earth's Rocky Crust" (3) "Erosion by Wind and Water". (20 minutes)

Core Activities

<u>Division of activity</u>.-- Each class period may be divided into two chief spheres of activity:

(A) sphere the first, which involves the device frequently used with success in lower grade geography classes- that of a vicarious class trip. A journey from Seattle to Los Angeles has been arbitrarily chosen for this unit, as there is opportunity to encounter practically every type of physiographic phenomena that the students should become familiar with, already referred to in the delimitation. Other routes west of the Mississippi River might easily be substituted (e.g., a route thru the Colorado Rockies, or the familiar Chicago-to-Seattle route by way of the northern route thru Minnesota, the Dakotas, Montana, Idaho, and Washington).

1. Basic teacher text will be <u>Guidebook of the Western United States, Part D., The Shasta Route and Coast Line</u>, by J. S. Diller and others, Washington, D. C., Government Printing Office.
2. The class members may be formed into specific committees, each group of which will agree to take charge of a designated portion of the route.
3. Basic discussion will come from the <u>Guidebook</u>, but the instructor should have a plentiful supply of illustrated literature, and encourage the students

to send by mail for additional free literature and small-cost printings about places to be visited en route. This must be done well in advance of the unit, however.

4. One panel discussion will be carried on by the students.
5. A map will be drawn showing, as the trip progresses, the route followed and the points of physiographic note recorded. Blank printed maps will obviate tracing time otherwise needed.
6. Many phases of physiography will be tied in, covering basic fundamentals of mountain development, plains, glaciers, soil; relation of physiography to agriculture, industry, and health; rivers, volcanoes, earthquakes, as examples of each are met up with on the trip.
7. Extensive footnote coverage in addition to a glossary of geologic terms in the <u>Handbook</u> provide a ready and useful reference for the students.

(B) sphere the second, which consists of a study of local town and characteristics of New England area, will appear under focus in the second portion of each class hour.

1. Each student will be assigned to write, or preferably sketch, the section of topography near his

home. He may use the detailed U. S. Geodetic Survey chart[1/] as a guide (this map, to be purchased for $0.15 from the Superintendent of Documents, Washington, D. C., shows locations of houses, roads, hills, swamps, border lines, and other land marks, as well as indication of height above sea level of each area of land). Artistically minded students will then go about the task of translating this data to one large paper map, with colors being used to indicate the different land heights. No attempt at model making will be allowed for in the class time at hand for the unit work.

2. The topic lends itself abundantly to use of visual aids- school journey, museum activity, moving pictures, still pictures, and other graphic devices, and especially objects of minerology. Reader should turn to appropriate section of the paper on Page .

<u>Time allotment</u>.-- Work in the unit, exclusive of final test, is planned to involve twelve 45-minute periods. In each class on an average of 15 minutes will be devoted to the Western trip, and an equal amount of time apportioned to the class discussion of the town area being mapped. A

1/ Complete details appear at the conclusion of this section, on Page 103.

tentative schedule is worked out as follows:

Activity	Estimated Time in Minutes
Introduction	15
Field trip	45
Panel	45
Visual aids	45
Western trip	150
New England	150
(Leeway time for first six on this list)	90
Grand Total	540

The Topographic Maps of the United States[1]

Source of the material.-- The United States Geological Survey is making a series of standard topographic maps to cover the United States. This work has been in progress since 1882, and the published maps cover more than 47 per cent of the country, exclusive of outlying possessions.

Design of the maps.-- The maps are published on sheets that measure about 16 1/2 by 20 inches. Under the general plan adopted the country is divided into quadrangles bounded by parallels of latitude and meridians of longitude. These quadrangles are mapped on different scales, the scale selected or each map being that which is best adapted to general use in the development of the country, and consequently, though the standard maps are of nearly uniform size, the areas that they represent are of different sizes. On the lower margin of each map are printed graphic scales showing distances in feet, meters, miles, and kilometers. In addition, the scale of the map is shown by a fraction expressing a fixed ratio between linear measurements on the map and corresponding distance on the ground. For example, the scale 1/62,500 means that 1 unit on the map (such as 1 inch, 1 foot, or 1 meter) represents 62,500 of the same units on the earth's surface.

1/ Excerpted from the reverse side explanation appearing on a quadrangular map of the United States Department of the Interior Geological Survey, 1937.

Three types of maps.-- Although some areas are surveyed and some maps are compiled and published on special scales or special purposes, the standard topographic surveys and the resulting maps have for many years been of three types, differentiated as follows:

Water features.-- Water features are represented in blue, the smaller streams and canals by single blue lines and the larger streams by double lines. The larger streams, lakes, and the sea are accentuated by blue water lining or blue tint. Intermittent streams--those whose beds are dry for a large part of the year--are shown by lines of blue dots and dashes.

Contour lines.-- Relief is shown by contour lines in brown, with occasional shading to represent light and present appearance of relief. A contour line represents an imaginary line on the ground (a contour) every part of which is at the same altitude above sea level. Only the contours at certain regular intervals are shown. Contour lines show the shape of the hills, mountains, and valleys, as well as their altitude. Successive contour lines that are far apart on the map indicate a gentle slope, lines that are close together indicate a steep slope, and lines that run together indicate a cliff.

Contour intervals.-- The contour interval, or the vertical distance in feet between one contour and the next, is stated at the bottom of each map. In order that contours

may be read more easily certain contour lines, every fourth or fifth, are made heavier than the others and are accompanied by figures showing altitude. The heights of many points--such as road intersections summits, surfaces of lakes, and benchmarks--are also given on the map in figures, which show altitudes to the nearest foot only. More precise figures for the altitudes of benchmarks are given in the Geological Survey's bulletins on spirit leveling.

(1) Surveys of areas in which there are problems of great public importance--relating, for example, to mineral development, irrigation, or reclamation of swamp areas.

(2) Surveys of areas in which there are problems of average public importance, such as most of the basin of the Mississippi and its tributaries.

(3) Surveys of areas in which the problems are of minor public importance, such as much of the mountain or desert region of Arizona or New Mexico, and the high mountain area of the northwest.

Aerial photography.-- The aerial camera is now being used in mapping. From the information recorded on the photographs, planimetric maps, which show only drainage and culture, have been made for some areas in the United States. By the use of stereoscopic plotting apparatus, aerial photographs are utilized also in the making of the regular topographic maps, which show relief as well as drainage and culture.

Mapping outside the continental United States.-- A topographic survey of Alaska has been in progress since 1898, and nearly 44 per cent of its area has now been mapped....The Hawaiian Islands have been surveyed, and the resulting maps are published....A survey of Puerto Rico is now in progress.

Chief groups of features.-- The features shown on topographic maps may be arranged in three groups: (1) water, including rivers, seas, lakes, canals, swamps; (2) relief, including mountains, hills, valleys, and other features of the land surface; (3) culture (works of man), such as towns, cities, roads, railroads, and boundaries. These are represented by symbols.

Legend.-- Lettering and the works of man are shown in black. Boundaries, such as those of a State, county, city, land grant, township, or reservation, are shown by continuous or broken lines of different kinds and weights. Public roads suitable for motor travel the greater part of the year are shown by solid double lines; poor public roads and private roads by dashed double lines; trails by dashed single lines. Additional public road classification if available is shown by red overprint.

The quadrangle.-- Each quadrangle is designated by the name of a city or town or prominent natural feature within it, and on the margins of the map are printed the names of adjoining quadrangles of which maps have been published. More

than 4,100 quadrangles in the United States have been surveyed.

Folios.-- Geologic maps of some of the areas shown on the topographic maps have been published in the form of folios. Each folio includes maps showing the topography, geology, underground structure, and mineral deposits of the area mapped, and several pages of descriptive text. The text explains the maps and describes the topographic and geologic features of the country and its mineral products.

Ordering maps and folios.-- Index maps of each State and of Alaska and Hawaii showing the areas covered by topographic maps and geologic folios published by the United States Geological Survey may be obtained free. Copies of the standard topographic maps may be obtained for 10 cents each. Geologic folios are 25 cents or more each. A circular describing the folios will be sent on request. Applications for maps or folios should be accompanied by cash, draft, or money order (not postage stamps) and should be addressed to THE DIRECTOR, United States Geological Survey, Washington, D. C.

Optional-Related Activities

Foreword.-- Selected related optional work is arranged under the headings of (1) changes in the earth's crust (2) mountains and volcanoes (3) plains, plateaus, and deserts (4) rivers and valleys. Correlation with broad aims of the unit is indicated following each exercise. Since all activities should be duplicated to the number which the instructor selects as pertinent to the abilities and interests of his pupils, and passed out to each individual student, it may be advisable for the instructor to devise his own system for designating which student might select the kind of activity best suited to him. This should provide a systematic method for adapting optional work to individual differences.

Changes in the earth's crust.--

(1) You may imitate sedimentation in a glass dish. Place sand, fine pebbles, and clay in the dish with water. Stir vigorously and let settle.
Answer these questions:
(a) Where does the finest material come to rest?
(b) Are the layers horizontal?
(c) What happens when you vary the rate of washing?
(General aim 1)*

(2) Commence a collection of rocks and minerals as a hobby. Look for granite, limestone, sandstone, quartz, and others to be picked up in the vicinity of home or school. You may identify the doubtful specimens by checking them with a minerology handbook to be secured in your town library. Also, boxes containing 50 or more small specimens of the most common minerals may be purchased inexpensively from any of the stores maintained at the larger museums of natural history, and in some stores. (Write the Chicago Museum of Science and Industry, Chicago, Ill., for further information.)
(General aim 7)

* General aims are listed on page 87.

(3) Study your neighborhood for examples of faults or folds, providing the rocks are tilted. If they are level, how can you give evidence of that condition?
(General aim 3)

(4) Bring to class for the exhibition table sample rocks you have found in the field to show weathering. Are there red or yellow stains? What causes them?
(General aim 3)

(5) To prove that water expands on freezing, fill a bottle of water and freeze it. Explain what relation if any this has to weathering.
(General aim 2)

(6) Heat a large piece of stone on one side, then cool it quickly by throwing cold water or ice on it. How does this simple experiment bring out an important principle of physiography?
(General aim 2)

(7) Look in your neighborhood for illustrations of roots prying rocks apart. This may be seen often on cliffs where trees are growing. Snap pictures with your camera of the best examples and bring photos to class.
(General aim 3)

(8) Watch and report on earthworms after a storm, when they are driven out of the swollen ground and deposit "casts", consisting of earth from the worms' stomachs. Explain how the worms assist in the weathering process.
(General aim 6)

(9) Look for glacial scratches recently uncovered. How do they compare with those longer uncovered?
(General aim 3)

(10) Keep your eyes peeled for a talus slope on a cliff. Answer these questions on a sheet you hand to the instructor:
   (a) Of what is the talus slope made?
   (b) Are fragments angular or round?
   (c) Are they all of the same kind of rock as that of the cliff?
   (d) Have any fragments been removed by water?
(General aim 9)

Mountains and volcanoes.--

(1) Trace the chief mountain chains of the United States on a blank map. Indicate height of mountain topography by differentiation of pencil shading.
(General aim 8)

(2) Collect photos of mountains for which pencil diagrams can be drawn and place in a class scrap book.
(General aim 5)

(3) Construct a model apparatus for imitating the folding of rocks. See Tarr and von Englen, Page 200.
(General aim 5)

(4) Write a paper on one of these topics:
(a) Ways in which mountain ranges have constituted barriers to retard exploration and settlement of regions in the United States;
(b) The importance of mining among mountain industries;
(c) How the Berkshire Hills exerted an important influence in settling the contest between Boston and New York City for commercial supremacy;
(d) The role played by mountains in the increase in the use of hydro-electric power;
(e) Why the term "Rocky Mountains" is better adapted to name the Western mountain range than was the term "Stony Mountains" first used;
(f) Presence of Arctic plants on the tops of high mountains near the tropics;
(g) Relation of mountains to irrigation;
(h) Forest reserves in mountain areas;
(i) Grazing in mountain regions.

(5) Make single diagrams for each of the ways in which a mountain may be formed, including methods of volcanic cone, lacolith, folding, faulting.
(General aim 8)

(6) Investigate the nature and construction of tunnels for railroads dug thru mountains, such as the Moffat and Cascade tunnels.
(General aim 2)

(7) Draw Contour cross-section outlines of Mt. Everest, Mt. McKinley, Mt. Ranier, Pike's Peak, and place them side-by-side in descending order of altitude.
(General aim 1)

(8) Without a great deal of trouble or extra equipment it is possible to set up an experimental geyser. See New Physical Geography, Page 245. (General aim 1)

(9) Soak a piece of limestone in water for a good many hours. Weigh it before and after soaking. How is your finding to be applied to any topic in physiography? (General aim 4)

(10) Trace a map of the world and place some mark of identification on the areas that to-day possess active volcanoes.
(General aim 8)

(11) Use the National Geographic Magazine index to select articles on the great earthquakes of San Francisco in 1906 and in Japan in 1923. If you have access to the newspaper files of a large city public library, find out how the New York Times reported the catastrophes. Did the paper attempt to give a scientific explanation of the earthquake?
(General aim 8)

(12) Make a list of the evidences we have that there is no trace of violent earthquakes in New England since glacial times.
(General aim 3)

Plains, plateaus, and deserts.--

(1) Compare the theories of formation of the Atlantic Coastal plain and the Great Plains of the West. How are they adapted to particular types of agriculture? Hand your answers on a paper to the instructor. See Arey, and others, Pages 484-503.
(General aim 9)

(2) Make a list of all the important Piedmont plains in the United States. How do they differ from any other type of plain?
(General aim 9)

(3) Consult Arey on Page 495 to determine the distinguishing features among these plain varieties:
(a) Lacustrine (b) flood plain (c) alluvial (d) glacial.
(General aim 1)

(4) Investigate the topic of the floor of Lake Agassiz and of Lake Bonneville. Show how they influenced the development of Minnesota, North Dakota, and Utah, respectively. Do the same for flood plains of the Mississippi River and the Grand River of Colorado.
(General aim 10)

(5) Compile a list of the chief plain and plateau regions of the United States, and with each a mean height above sea level. Does the result indicate that plateaus are always above the level of plains, from sea level?
(General aim 10)

(6) Look in several physiography textbooks and make reproductions of diagrams that depict plateaus, and devise your own diagrams from photographs. See Arey, Pages 505-511.
(General aim 2)

(7) Consult Arey, Page 528, for diagrams of the New England erosion plane, and including Mount Monadnock.
(General aim 3)

(8) Contrast the total areas covered by the Sahara, the Gobe, and the Mohave deserts. Write a summary of their economic advantages and disadvantages to the continents on which they are located?
(General aim 1)

(9) Using the Bright Angel, Arizona, quadrangle (to be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C., for $0.15), a detailed map by the U. S. Geological Survey men, mold a relief model from clay or other material of the Grand Canyon portion shown. Exaggerate the vertical scale.
(General aim 5)

Rivers and valleys.--

(1) If possible, inspect streams in your home town to see whether they are receiving rock waste from the valley side.
(General aim 4)

(2) Secure a price list from the U. S. Coast Guard Geodetic Survey, Washington, D. C., that gives publications on the topic of deltas. Price list is free, and publications may be purchased at an extremely nominal cost.
(General aim 8)

(3) Think out the answer to this question: From which does rain water run off the most readily (1) the road (2) a lawn (3) the woods.
(General aim 9)

(4) Fill a wood trough with pebbles, sand, and clay. Run water thru it at different speeds. Record your results.
(General aim 5)

(5) List the valleys and hills that are best known in your community, or others that may interest you particularly. Note those you think have reached maturity. Are the streams still cutting away, or is the flow too slow for an amount of wearing away?
(General aim 3)

(6) Write a paper on some large river of the country or the world in reference to the ways in which it is changing or has changed the topographical features of its vicinity. Your public library should contain books on one particular river alone, such as the Amazon, Missouri, Nile, Colorado, and so forth.
(General aim 10)

Test Material

Foreword.-- This material is designed as an end-of-unit examination, and will take up the entire 45 minute period. Four "different" types of tests comprise the test matter: (1) true-false statements (2) matching (3) fill-in statements (4) multiple choice statements. Basis for completion of fill-in declarative sentences will be found in the delimitation of the paper. Here one is in possession of the foundations of the approximate anticipated answers or blank completions. Testing of pupils with regard to recall is the goal, as contrasted with the testing of recognition in the other fundamental type exercise in foregoing (1), (2), and (4).

This test may well be repeated from three months to a year after the unit is completed to ascertain the degree of permanency of retention by pupils.

True-false statements listed.--

(1) An artesian well delivers water from beneath a non-porous rock layer.

(2) Millions of years ago, most geologists believe, the world was in a molten condition.

(3) On the entire surface of the earth, an earthquake is recorded by man's instruments on the average of once each day.

(4) Of the three chief types of rock, sedimentary is the most common on the surface of the earth.

(5) Snowslides consist of accumulation of talus.

(6) Marble is an igneous rock.

(7) Rainfall, melted snow, ice, ground water, and lakes are chief sources of river water.

(8) Erosion is the wearing away of the solid part of the earth.

(9) Meanders are usually found in deep gorges.

(10) An earthquake involves movement of the earth's crust.

(11) A coastal plain is formed by the lowering or rising of the ocean bed.

(12) Glaciers move faster in the middle than on the sides.

(13) Niagara Falls is slowly moving upstream.

(14) Egyptian, Babylonian, and Middle-Eastern early civilizations were built on ocean shores.

(15) Soil is formed as the result of erosion and weathering.

(16) Sedimentary rocks are made thru the interaction of heat and pressure.

(17) Mountains are built by means of volcanic action, erosion, and warping of the surface of the earth.

(18) Glaciers are confined to the Arctic and Antarctic areas of the earth.

(19) After long period of erosion, the seashore line will tend to straighten out.

(20) The surface of the United States is slowly being brought toward a level condition (that is, forces of erosion are stronger than forces of uplift).

(21) Sandstone is formed from material eroded from the land.

(22) Water in the ground extends down to bedrock.

(23) Marine erosion is due mainly to shore currents.

(24) A tidal bore consists of a series of large waves.

(25) Both lake and river deposits form soil that is inferior in quality to soil formed by glacial deposits.

The matching exercise proposed.-- Group 1:

( ) medial moraine

( ) névé

( ) glacial scratch

( ) faulting

( ) earthquakes

1. most common in regions of growing mountains
2. packed glacial snow
3. uniting two lateral moraines
4. cause of earthquakes
5. material evidence of one-time presence of glacier
6. found primarily in White Mountains
7. chemical action of water on rock

Group 2:

( ) geyser

( ) young mountain

( ) plateau

( ) drumlin

( ) tree line

1. found most frequently in desert areas
2. oval hill of glacial drift
3. worn down to the peneplain stage
4. surface water that came in contact with hot lava
5. extremely ragged
6. boundry between vegetation and bare rocky surface
7. found chiefly in Rocky Mountain area.

Printing of the fill-in blank exercise.-- TO THE STUDENT: When a short blank _____ appears, the statement may be completed by one word; when a long blank is indicated ____________, the sentence should be completed with a phrase of two or more words.

(1) Another term or name for granular ice formed from snowfields in the process of making a glacier is _____. (Delimitation VIB)

(2) _____ moraines are built up at the ice mass front. (VIB1)

(3) Lacolith mountains are raised by _____ intrusion. (VB)

(4) Earthquakes are recorded on a _____ instrument. (VIIIA)

(5) New England agriculture is hampered by glaciers which left behind for us a great amount of glacial soil, hilly topography, and _____. (IXA)

(6) The only mineral wealth in New England is _____ stone. (IXB)

(7) The age of the earth is estimated by the majority of geologists to be roughly _____ billion years. (IA)

(8) Igneous rocks are formed as the result of ____________. (IIIA)

(9) Old mountains may be lowered as far as the ____________. (VC)

(10) The first 20 to 100 miles out to sea, a relatively shallow area, is called the ____________. (IVA)

(11) The interior of the earth is believed to be in the condition of a ________. (IB)

(12) Rock disintegration beneath the soil is caused by action of the compound, or liquid, ____. (IIE)

(13) A plateau may be defined as an ________. (IVB)

(14) The topography of New England reaches highest levels in the ____ and ____ sections. (IX)

(15) A delta is built up by ________. (VIIE)

(16) The geologic era in which we live is called the ____ era.

(17) The idea that the world was formed when a great globular mass of hot gas gradually cooled is known as the ____ Hypothesis. (IA)

Multiple choice statements.--

(1) At Boston one finds (a) peneplains (b) drumlins (c) buttes (d) volcanoes now extinct (e) traces of frontal moraines.

(2) New England, in its physical geography, most resembles (a) Russia (b) France (c) Ireland (d) India (e) Scandinavia.

(3) The White Mountains are (a) old mountains (b) recently formed mountains (c) volcanic (d) mostly formed above the timber line (e) good for farming.

(4) New England has been entirely covered by (a) a glacier (b) a disastrous flood (c) rich soil (d) a large deposit of coal (e) monadnocks.

(5) The highest mountain in New England rises above sea level about (a) 4,000 feet (b) 6,000 feet (c) two miles (d) 14,000 feet (e) 16,000 feet.

(6) The most conspicuous mountains of New Hampshire are the (a) Green Mountains (b) Taconic Range (c) Berkshires (d) White Mountains (e) Appalachians.

(7) The most extensive areas of nearly level land in New England lie in (a) the Connecticut Valley (b) Southern Vermont (c) Cape Cod area (d) Western Maine (e) central Massachusetts.

(8) This feature does <u>not</u> prevail in the New England area: (a) good harbors (b) waterfalls furnishing water power (c) numerous lakes for water supply purposes (d) mountains for tourist attraction (e) abundance of residual soil for agriculture.

(9) The bedrock of most of New England is (a) sedimentary (b) igneous (c) metamorphic (d) granite (e) residual.

(10) Waterfalls have played important roles in the development of the textile industry and in general city growth in all but one of these cities: (a) Fall River (b) Fitchburg (c) Boston (d) Lawrence (e) Lowell.

(11) Erosion is prevented by (a) vulcanism (b) terracing (c) stream deposition (d) glaciation (e) diastrophism.

(12) A type of igneous rock is (a) limestone (b) marble (c) sandstone (d) conglomerate (e) granite.

(13) There could be no erosion without which one of the following: (a) metamorphism (b) diastrophism (c) volcanic action (d) the atmosphere (e) faulting.

(14) Poor lands are best conserved by (a) keeping them in cultivation continually (b) using them for timber and pasture (c) the constant removal of crops (d) practice of crop rotation (e) frequent plowing.

A key to test problems.--

TRUE-FALSE STATEMENTS:

1. T	11. F	21. T
2. T	12. T	22. T
3. F	13. T	23. T
4. F	14. F	24. T
5. F	15. T	25. F
6. F	16. F	
7. T	17. T	
8. T	18. F	
9. F	19. T	
10. T	20. F	

MATCHING EXERCISE:

Group 1.	(3)	Group 2.	(4)
	(2)		(5)
	(5)		(3)
	(4)		(2)
	(1)		(6)

FILL-IN BLANKS:

1. névé	11. molten solid
2. terminal	12. water
3. lava	13. an elevated plain
4. seismograph	14. northern and western
5. boulders, or rocks	15. deposit of sediment at a river's mouth
6. building, or construction	16. Cenozoic
7. two	17. Nebular
8. cooling of molten rock material	
9. peneplain	
10. continental shelf	

MULTIPLE CHOICE SELECTIONS:

1. (b) drumlins	8. (e) residual soil
2. (e) Scandinavia	9. (a) sedimentary
3. (d) old mountains	10. (c) Boston
4. (a) glacier	11. (b) terracing
5. (b) 6,000 feet	12. (e) granite
6. (d) White Mountains	13. (d) the atmosphere
7. (a) Connecticut Valley	14. (d) crop rotation

Visual Aids [1/]

MOUNTAIN BUILDING

Motion Pictures

"Mountain Building"

In this University of Chicago produced, 11 minute, 16 mm., sound, 1935, Erpi film, significant events in geological history in relation to mountains and movements of the earth's crust are emphasized. Early history of formation of the Appalachian Mountains and the story of the Lewis Overthrust are included. Significance of the phenomena to mining and structural engineering is taken up.

"Maker of Mountains"

This is a one reel, 16 mm., silent Educational Films Corporation of America film, which illustrates the geological formations of mountains. The film is recommended by some critics for supplementary use with other films on the same topic.

GOVERNMENT PRINTING OFFICE PUBLICATIONS

Guidebook of the Western United States. The traveler is entertained by this series of volumes in that they provide him with specific information about the many points of scenic interest thru which the journey is made. A route

1/ Methods for using visual aids in general science are treated in the visual aid section of the unit organization in weather. See Page 79.

map in each book is arranged on twenty separate sheets as the route is broken down into small sections.

A. Part A. Northern Pacific, route from Minnesota to Seattle includes a side trip to Yellowstone National Park, and is a Geological Survey publication, Bulletin 611. Price $1.00.

B. Part C. Sante Fe Route, with a side trip to Grand Canyon, contains two-hundred pages, maps, photographs. Survey Bulletin 614. Price $1.25.

C. Part D. Shasta Route and Coast Line is a small 142 page volume, 615, with price of $0.50.

D. Part E. Denver and Rio Grande Western Route, 1922, 226 pages, maps, Bulletin 845. Price $1.00.

E. Part F. Southern Pacific Lines, New Orleans to Los Angeles, 1933, 304 pages, Bulletin 707. Price $1.00.

The entire number of this series of books is adequately supplied with photographs, diagrams and minutely detailed maps. Guidebook to Geology of Rocky Mountain National Park, Colorado. National Park Service, 1934, 32 pages, serial I 29.6:R5917. Government Printing Office, price $0.10.

MOUNTAINS

National Geographic Magazine

1. Blacker, L.V.S., "Aerial Conquest of Mt. Everest," 54:127-162, 35 illustrations, Agust, 1933.

2. Fernsworth, L.A., "Andora Mountain Museum of Feudal Europe," 64:493-512, 21 ills., October, 1933.
3. Kerby, McFall, "Colorado...Where Water Has Transformed Dry Plains into Verdant Farms, and Highways Have Opened up Mineral and Scenic Wealth," 68:1-63, 56 illustrations in black and white, 12 in color, July, 1932.
4. Minnigerode, F.M., "Beauty of the Bavarian Alps," 49:642-649, 16 ills., August, 1926.
5. Mittelholzer, Walter, "...Conquering the Alps, the Ice Peaks of Spitzbergen, of Persia, and Africa's Mountain of the Moon," 49:444-498, 53 ills., April, 1932.
6. Moore, W.R., "High Lights in the Peruvian and Bolivian Andes," 18 ills., all in color with autochromes, 51:218-235, February, 1927.
7. __________, "Skyline Drive of the Pyrenees Mountains," 24 ills., in color, 62:434-453, 1937.
8. Rock, Joseph F., "Glories of the Minya Konka," 78 ills., in black and white; 12 ills., in color; 63:81-120, July, 1932.
9. Roy, Leonard C., "From Notch to Notch in the White Mountains," 30 ills., 63:73-124, July, 1937.
10. Shippee, Robert, "Air Adventures in the Alps," 40 ills., 63:81-120, January, 1933.
11. Williams, Maynard O., "First Over the Roof of the World by Motor," 45 ills., 61:321-336, March, 1932.

SHORELINES AND RIVERS: General Material

1. Russell, Carl P., "White Sands of Alamogordo, N.M.," National Geographic Magazine, 12 ills., 68:250-264, August, 1935.
2. Simpich, Frederick, "Men Against Rivers," 22 ills., 71: 767-794, price $0.50, June, 1937. (Write National Geographic Magazine).
3. "Floods of 1936," Part 1, New England Rivers, U. S. Geological Survey, Water Supply Paper 798, price $0.70.
4. "Good-Natured Map of Alaska," cartoonograph wall map in colors, Alaska Steamship Co., Pier 50, Seattle 4, Washington. Free.
5. Fowlkes, John G., editor, Educators Index of Free Materials, Randolph, Wisconsin, "Conquest of Colorado," material on Boulder, Parker, and Imperial dams. Materials available for two week periods. 8" x 10" photographs averaging 35 to a set; return postage must be prepaid. U. S. Department of Interior, Bureau of Reclamation, Washington, D. C.
6. Moore, Robert W., "Busy Corner-the Cape of Good Hope," National Geographic Magazine, p. 197-223, August, 1942.

VOLCANOES

National Geographic Magazine

1. Atwood, W.A., "Crater Lake and Yosemite thru the Ages," 7 ills., in black and white, 13 ills. in color, 71:327-343.

2. Dyott, G.M., "Falcon of the Pacific's Newest Island," 8 ills., one half page map, 54:757-766.

3. Hubbard, Bernard R., "World Inside a Mountain: Aniachad, the New Volcanic Wonderland of the Alaska Peninsula," 34 ills., 60:319-345.

4. Ladd, Harry S., "Volcanoes of Equador," 42 ills. in black and white, 12 ills. in color, 55:49-93.

5. Jaggar, T.A., "Adventures of the National Geographic's Society Pavlof Volcano Expedition to Alaska," 30 ills., 60:109-134.

6. Matson, Eric, "Multicolored Cones of Cappadocia," 20 ills. in color, 67:769-800.

7. Verhoogen, Jean, "We Keep House on an Active Volcano," 28 ills., 76:511-550.

VOLCANOES

Kodachrome Slides 1/

1. Be 36: Volcanoes — a close-up of a crater near San Jose, Costa Rica.

2. Be 33: Volcanoes — effect of volcanic ash on vegetation on quaint mountainside setting, in Costa Rica.

3. Be 35: Volcanoes — photo of a crater showing steam and smoke just before eruption.

4. Be 34: Volcanoes — Momotombo, showing smoke from crater, and lava flow from down the mountainside, near Managua, Nicaragua.

EROSION

Kodachrome Slides

1. Be 24 — eroded canyons in Death Valley, Cal.

2. Be 27 — landslide resulting from heavy rain in Puerto Rico National Forest.

3. Be 21 — river action, old pot holes in rock of stream bed, Sierra Nevada Mountains, California.

4. Be 67 — sand dunes, sand bar in Lake Michigan, also Indiana dunes.

5. Be 26 — water washed formations, red sandstone cliffs, New Mexico.

1/ Made by the Eastman Kodak Co., Rochester 5, New York.

6. Be 53 wave action, granite boulders showing wear from water.
7. Be 37 driftwood, Eagle Point Beach, San Juan Island, Washington.
8. Be 23 weathering of rock, change in color because of iron oxidation, fresh surface in foreground, in Santa Anna mountains, California

NATIONAL PARKS (INCLUDING HOT SPRINGS AND GEYSERS)

Illustrated Articles

1. Vosburgh, Fred. W., "Fabulous Yellowstone," National Geographic Magazine, 15 ills. in black and white, 9 ills. in color, price $0.50, 67:769-794.
2. Wisherd, Edwin L., "Where Hot Pools Seathe and Geysers Spout," 9 ills. in color, in National Geographic Magazine, p. 775-782, June, 1940.
3. "Warm Springs of Georgia, Their Geologic Relations and Origin," a summary report, 1937, U. S. Geological Survey, Water -supply paper 819, Superintendent of Documents, Washington, D. C. # I 29.6:Y 317/936 price $0.45.
4. "Geysers of Yellowstone National Park," list 35, 28 p. ills., Superintendent of Documents, Washington, D. C., price $0.15., # I 29.6:Y:819.

CRUST OF THE EARTH AND SOIL OF THE EARTH

Motion Picture

"Earth's Rocky Crust," is an 11 minute, 16 mm., sound film that presents the dynamic features of physiography, and endeavors to show that forces are still working to reshape the earth. Importance of the water cycle receives recognition. Formations of the three chief types of rocks are illustrated. Finally, mountain deterioration is also covered in this Erpi film.

Illustrated Articles

1. Carr, William, "As the Grass Goes," an article on denudation and soil spoilage and washing away appears in Natural History Magazine, p. 156-162, with 13 ills., April, 1946.
2. Comstock, Anna B., Handbook of Nature Study, Comstock Publishing Co., Ithaca, N. Y., 1941, p. 736-755, presents photographs illustrating particular phases of surface physiography.
3. "Stratosphere, Troposphere, and Curvature of the Earth," is an unframed print in black gravure, 14 1/4" by 23", as photographed by a camera man from Explorer II at the greatest altitude ever reached by man. Price $0.50. National Geographic Society, Hubbard Memorial Building, Washington, D. C.

4. Miscellaneous physiographic diagrams in the National Geographic Magazine collection. See list 35 for complete enumeration. Example: "Physiographic Diagram of the United States," No. 6. Price $0.35.
5. "Panorama of Physiographic Types," Geographical Press, Columbia University, New York. Many of the questions contained here may be used directly or indirectly in the study of physiographic bases of regional conditions. Present price $0.35.
6. Maps. See List 53 of Government Printing Office. Write to Superintendent of Documents for free list.
7. Alden, W. C., "Hanging Valleys and High-Level Benches in Glacier National Park," Science (July 23, 1943).
8. Sloane, E., "Back to a Round Earth," the air age calls for global geography in Popular Science (Nov., 1944).
9. "Geologic Structure of the United States," in Science News Letter, includes a four-by-six map (September 9, 1944).

GLACIERS

Kodachrome Slides

1. Ar 645 Glacial ice cave, Big Four Mountain, Washington
2. Ac 169 Glacial "U" cirque, from the cog train on Mt. Washington
3. Be 61 Glaciers, moraine of Angel Glacier, Jasper Park
4. Be 62 Glaciers, Angel Glacier, showing movement of ice

5. Be 63 Glaciers, Saskatchewan Glacier at Columbia Ice Field
6. Be 64 Glaciers, glacial boulders in Astoria Creek, Jasper Park
7. Be 65 Glaciers, nose of Angel Glacier from moraine, Jasper Park

Government Printing Office Publications

1. "Glaciation in Alaska," is found in Paper 170A, I1916: 17-A, p. 1-8, U. S. Geological Survey, Superintendent of Documents, Washington, D. C., price $0.15.
2. "Guide to Geology of Rocky Mountain National Park, Colorado, 1944," I29.6 R5917, Superintendent of Documents, 32 p., price $0.10.
3. "Origin of Scenic Features of Glacier National Park," is another government printing office publication. Number I29.6: G45/4. List 35. Price $0.20.
4. "Mount Ranier and Its Glaciers," Mount Ranier National Park, 48 p., map. Number 129.6: M86/4/936. Price $0.15.

GLACIERS

Motion Pictures (Wilson catalog, Dewey number 551.31)

1. "Glaciers" is a film in the Harvard Pathe series, a 15 minute, 16 mm., silent or sound picture, made in 1929, and gives the classification, modes of origin, motion and characteristics of existing glaciers and the work

they do to change the landscape in frequent erosion and deposition.

2. "Birthplace of Icebergs" constitutes an 11 minute, 16 mm., 20th Century-Fox production, and pertains to the study of the largest tide-water glacier in the world, which empties into the Gulf of Alaska. Ice river moves down the river to the sea, collapsing and discharging tremendous chunks of ice. The two cherished theories of the formation of ice are contrasted.

3. "Climbing up into Canada's Past," a 12 minute, 16 mm. film produced by the Canadian Pacific Railroad, deals with the remnants of the Great Ice Cap, Illecillewaet Glacier.

4. "Geological Work of Ice" is an 11 minute, 16 mm., sound film that may be secured in 35 mm. width also. A 1935 Erpi production, it takes up the gradational activity of ice in breaking of rock in freezing weather. The story of glaciers and their advances and retreats in past geological periods are brought into focus.

5. "Study of a Mountain Glacier" is a ten minute, silent, 1921 produced film that shows how a glacier starts and grows. It likewise brings out parallel stages in glacial formation today. Origins of the moraine, crevasses, "ice tables," and glacial rivers are taken under consideration.

VOLCANOES

Motion Pictures (Wilson catalog, Dewey number 551.2)

1. "Volcanoes," a 15-minute, 16 mm., silent, Eastman film finds quiet overflow types compared with those having explosive eruptions. Hawaiian, Palisades, South American, Mt. Vesuvius, and Mt. Lassen Peak volcanoes are studied. Film was made in 1931.
2. "Volcanoes," a Harvard Pathe series production, one reel, 35 mm., silent film shows how volcamic activity changes the surface of the earth. Contrast is made of active and inactive volcanoes, including eruptions at Vesuvius, Etna, Kilauea. Telephotography, animated drawings and colors are used.
3. "Volcanoes in Action," a University of Chicago physical science series film, has sound, comes in both 16 and 35 mm. size, explains dikes, batholiths, sills, laccoliths in reference to their formation; it describes products of volcanism, including lava, cinder, ash; pictures of active and inactive volcanoes thruout the world appear. This Erpi 1935 film lasts 10 minutes.

EROSION

Motion Pictures (Wilson catalog, Dewey number 551.3)

1. "Erosion by Wind and Water," a 12 minute, 16 mm., sound, EPS film contains material on plunging water falls, caverns, rivers emptying into the sea, Cave of the Winds,

stalagmites and stalactites, Williams Canyon, Falls of South Cheyenne Canyon, erosion, Canyon Creek, Wheeler national monument, stone spires, Valley Temple of Sinawava, Virgin River, curious rock formations, eye-hole formations.

2. "Formation of the Soil" is a 15 minute, 16 mm., sound, Eastman film. It takes up elementary facts about the rock-soil cycle by means of demonstrations, animations, actual photos, as well as the disintegration of rock, including the work of weather, stream erosion and transportation, glaciers, wind, waves, rain, air, plants, animals.

3. "Wearing Away the Land" is a 10 minute, 16 mm. sound, 1931, Erpi film illustrated how rocks are formed, rock decomposition, making of sink holes and caves, how blowing sand erodes the surface of the earth, and manner in which waves are reshaping the coastline.

4. "Work of the Atmosphere" runs for 11 minutes, is 16 mm., a sound picture, 1935, Erpi production illustrating the part played by the atmosphere thru disintegration of rocks, erosion and sandblast action on rocks and trees, and brings out connection of work of atmosphere and formation of soil. Also, it may be used in a unit on weather and climate.

Bibliography, With Notes

**Beauchamp, Wilbur L., Mayfield, John C., and Young, Joe W., Everyday Problems in Science, Scott, Foresman and Co., Dallas, 1940, p. 311-347. Teachers' guide book accompanies the text. Graphs of subject matter are included for each unit, in addition to a wealth of practical suggestions for teaching of the seventeen units. This takes in information on apparatus and supplies. Text is strong in presenting cross-section drawings to bring out weather principles. Larger pivotal questions or problems are basis for attack.

*Brockton, Mass., Public Schools, A Course of Study in Junior High School Science, 1942, p. 88-106. Four chief questions for the unit are enumerated: (1) What are the fundamental factors which cause weather? (2) What causes atmospheric disturbances? (3) What is the work of the Weather Bureau? (4) How does man adapt himself to changing conditions? Proceeding a list of objectives come desired outcomes, in the pale of understandings, abilities, appreciations. Exploration suggests a pre-test. Presentation involves facts which the teacher should stress. Assimilation is brought about by expressional activities, demonstrations, discussion, research and appreciation activities. Rather sparodic delimitation of terms is attempted. More helpful are suggested methods for correlating with English, drawing, mathematics, manual arts, household arts and health education. True-False, completion and multiple choice tests

*Intended for instructor only; ** these sources suitable for either student or teacher.

are sufficiently long to be used directly from this source if desired.

**Carpenter, George C., and Wood, Harry A., Our Environment: How We Use and Control It, Allyn and Bacon, San Francisco, 1942, p. 547-576. Several important and useful home, school, and workshop projects are concerned with in detail. Systematically arranged are details on materials needed, procedure, observations, conclusions, and practical applications. Introduction to the relation of solar energy to the weather problem is made thru a list of practical survey questions. Considerably of aid should prove the inches-millibar conversion table on Page 577. A summary, key statements, and thought questions and exercises bring the material to conclusion.

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*Freeman, Nevin M., Physiography of the Eastern United States, McGraw-Hill, New York, 1938, p. 343-391. A seven-hundred page volume, with photos, diagrams and large double page maps in index sections, discusses under New England as a whole province, the White Mountain section, Green Mountain area, Taconic, Seaboard lowland, Connecticut valley lowland, New England shore. On Page 365 appear five profiles of New England upland south of the White Mountains. The text covers territory as far west as the central lowland west of the Mississippi, Ozark plateau and Ouachita province. A companion book by the same author, Physiography of the Western United States, presents a comprehensive summarization of the physiographic features of Western United States: Great Plains, Rocky Mountain System, the Intermontane Plateaus, and the Pacific mountain system. This may serve mainly as a source book for the instructor.

**Kimball, Dexter S., Editor, The Book of Popular Science, the Grolier Society, New York, 1945, vols. 1, 2, 7, 8, 11. Photographs in vol. 1, p. 99-110, are of note in that they constitute pictures that are landmarks in the history of weather instruments, about 1920. In vol. 7, p. 2263-2271, is an account of climates of the past, with illustrations to augment a well-told story of climate developments. Other topics pertain to cold, effect of humidity, the radio-meteorograph (radiosonde), weather research, Weather

Bureau ascension balloons, upper air weather observations. "The Weather Mystery," p. 3699-3708, goes into detail on the meaning and implications of climate, in terms of places on earth where contrasting atmospheric conditions prevail.

*Missouri State Committee, Missouri at Work on the Public School Curriculum, Secondary School Series, Bulletin 6, 1941, p. 87-97. Main theme: How does man control changes taking place on the earth's surface? Suggested objectives are followed by outline of subject matter content and possible teaching procedure. There are four alternative approaches for problem 1, for instance; collecting information is covered under field trips, references, new words, experimentation, and observation. Interpretation is outlined under discussion and activities. Conclusions drawn and application capitulate the outline. A brief true-false, matching, and multiple choice battery of tests is likewise included.

*Murray, John C., and Hjort, Hohan, The Depths of the Ocean, Macmillan and Co., New York, 1912. A voluminous treatise on oceanographical investigations, depths and deposits of the ocean, physical oceanography in addition to plant and animal life of marine character. Concentration is made on depths and deposits in the North Atlantic, illustrative of which are several colored folio maps. Instruments used to

determine ocean depths are dealth with exhaustively, in relation to temperature, chemical reactions, fauna and flora of ocean depths. Data for all oceans likewise is to be found. This volume is best suited as the instructor's source book, and is chiefly useful as historical background in measurement of ocean depths.

**Packard, L. O., Overton, Bruce, and Wood, Ben. D., Our Air-Age World, MacMillan Co., 1944, p. 28-49. Consult p. 31 for a graphic picture diagram of the high altitude problems of aviation. On p. 37 appear two maps contrasting locations of the wind belt regions in January and in July. Compare photos of clouds on p. 39 with those of the U. S. Weather Bureau posting chart. Guides to study are printed on p. 40 and p. 48. A section of a U. S. Weather Bureau map on p. 43 constitutes a good facsimile.

*Ridgley, D. C., and Ekblaw, W. E., Influence of Geography on Our Economic Life, Gregg Publishing Co., Toronto, 1938. A discussion of the factors of environment occupies parts 1, 2, 3, followed by the basis to the interpretation of economic activities in part 4, while section 5 pertains to climate. Climates of the world are catalogued into sixteen different types. Text is prepared in units convenient for daily study. Maps, graphs, and illustrations carry legends that are not only explanatory, but that tend to raise

questions to be answered from the text, from general observation, and from independent thinking. Statistical tables are included in the appendix. Bar graphs are frequently utilized. Detailed indexing increases the value of this book for pupil reference work.

*Rochester, N. Y., Board of Education, Course of Study in Science, 1939, p. 24-35. Five separate units are based on unit-statements: (1) Weather conditions are the result of definite causes; (2) Weather forecasts serve industry; (3) Large bodies of water invluence climate; (4) Science has made it possible for man to adopt his life and work to different conditions of climate; (5) Weather conditions for a given location are somewhat local, but are usually part of a great air movement passing across the country...General statements for each unit are followed by tentative motivation problems and minor concepts in addition to experiments. This guide may serve as teacher outline for planning class work.

*Tarr, Ralph S., and Von Engeln, O. D., New Physical Geography, MacMillan Co., 1942. This book is a thorough elementary physiography teaching volume. Topics covered include: earth as a planet, general features of the earth, changes in the earth's crust, rivers, plains, plateaus, mountains, volcanoes, earthquakes, geysers, glaciers, lakes, swamps,

the ocean, atmosphere, wind and storms, weather and climate, distribution over U. S. of plants and animals. There is a prolixity of diagrams, maps, photographs, with nearly every major point made in prose text being pictorially explained. Each main subject under discussion is followed by a three or four line summary. Topical outlines are presented for each chapter. Complete appendices are concerned with topics such as revolution of the earth; minerals, rocks and soils; tides; magnetism; map projections; field work; teaching suggestions.

*Rulon, E. J., The Sound Motion Picture in Science Teaching, Harvard University Press, Cambridge, 1933. This book aims to relate incidents of a controlled experiment conducted over a three month's period in ninth grade general science classes in three Greater Boston school systems to determine the effectiveness of the use of the sound picture movie especially prepared for the purpose. Seven films were used in units in biology and physiography. Findings brought out evidence to indicate decided superiority over the ordinary text book system so generally in practice. Especially was this true when the students were tested months later to see how much material they had actually retained. Book helps to suggest to the science teacher several ways in which he may use the sound motion picture to increased success.

**U. S. Government Printing Office, Railroad Travel Books, Superintendent of Documents, Washington, D. C., 1941. These travel guides branch into minute detail concerning all towns and cities along major Western U. S. railroad thoroughfares. Colored maps point out rivers, communities, mountains and other phenomena to be seen from car window along routes. Both historical and geographical backgrounds are minutely covered, accompanied by frequent pertinent photographs. Routes include the California coast route, the Colorado mountain route, the Washington-Oregon route, the Minnesota-Dakotas-Montana-Idaho-Washington route. One of these is used as basic manual for physiography unit of this paper.

*Thomson, J. Arthur, editor, The Outline of Science, G. P. Putnam's Sons, New York, 1922, p. 761-790, vol. III. Science of weather is treated from English viewpoint by professor of natural history at University of Aberdeen. Result is notable for cloud photographs, and includes several climatic maps of the British Isles together with talks about English climate in detail. Although photos of weather instruments are now outdated, they prove interesting in showing progress of the 1920's in that field. See illustration facing p. 774 for rainbow material. This reference book is suitable for either student or instructor usage.

*Suitable for use as reference by instructor only.

**Weather Bureau <u>Circular N</u>, Department of Commerce of the United States, Washington, D. C., 1941. This handbook presents detailed information pertaining to types of precipitation, clouds, measurement of wind and air pressure, and is particularly strong in its section on weather instruments and their maintenance. Illustrative matter is freely interspersed. Leaflets of amendment have been issued from time to time since 1941. Publication deals primarily with technicalities of weather observing, not weather forecasting, and is used in preparation for Civil Service examinations. Book may be secured for $0.60 from the Superintendent of Documents, Washington, D. C. Other lettered-title circulars are likewise obtainable, for reference to which please consult government list of free and inexpensive publications.

*Woodring, Maxie N., Oakes, Mervin E., and Brown, H. Emmett, <u>Enriched Teaching of Science in the High School</u>, Bureau of Publications, Teachers College, Columbia University, New York, 1941, Section II. This is an extensive guide to sources of supplementary and enrichment material which may be procured at a low cost. Attempt is made by the authors to meet such needs as (1) new and different types of laboratory activities; (2) content for the modern curriculum;

**Suitable for use by either pupil or instructor.

(3) suggestions for integration of science within its own area and with other areas of knowledge; (4) opportunities for expanding the teacher's horizons. Sources of free and inexpensive materials pertaining to crustal earth movements, prehistoric life, earth minerals, special geological localities, geological surveys and maps, student activities, work of the weather bureau, meteorological data, weather phenomena are located p. 13-26.

**Wright, Ernest H., and Wright, Mary H., editors, Richards Topical Encyclopedia, J. A. Richards Publishing Co., New York, 1943, p. 193-278. Section of encyclopedia consists of these units: how the weather makes history; how the sun makes our climates; summer heat and winter cold; a yardstick for the weather; an ocean of air; what makes the wind blow; traveling mountains of the sky: where the rain came from; up in a cloud; how a snowflake is made; how the air is weighed; weather proverbs of long ago; why the sky is blue; don't blame the weather man. Suitable in particular for junior high school students. Each unit is subdivided into minor topics. Interesting facts are explained, along with things to think about, picture hunt, related material, practical applications, leisure time activities, summarizing statements. Unit on weather superstitions is noteworthy.

*United States Army, Technical Manual 1-235, The Weather Observer, 1942, with periodic supplements. This so-called weather Bible solidly spreads forth a complete set of data on all phases of weather observing, reporting, clouds, precipitations, obstructions to vision, instruments, teletype maintenance and line procedure. Contains unusually clear and complete prose limitation for all types of clouds. Glossary of meteorological terms arranged alphabetically should prove helpful. Conscientious indexing facilitates reference. Nearly 1000 pages. Volume may be used at any large city library, sometimes placed on hand in statistics room.

*Salisbury, Rollin D., Physiography, Henry Holt and Co., New York, 1927. This volume, best adapted for instructor's reference, is divided into main sections of: the lithosphere, work of the atmosphere, the atmosphere, the ocean, accompanied by twenty-six plates in color and numerous black-and-white illustrations. Any of latter may advantageously be shown in opaque projector. A number of isothermal charts in addition to numerous copies of Weather Bureau maps have been included. Two-hundred pages in latter portion of book are devoted to weather and climate as they relate to physiography.

*Annotations of Recent Science Publication Articles in Science News Letter

"Weather Stations Abroad," Science News Letter, August 31, 1946, p. 140. This article contains a description of Weather Bureau expansion in Alaska, Greenland, the Pacific area as well as stations taken over from the Army Air Force on the continental United States.

"Exploring Upper Air," Science News Letter, August 24, 1946, p. 115. The author deals with V-2 rockets from Germany which are serving Army, Navy and scientific groups in research into atmospheric conditions above the earth.

"Radar Stations Locate Bad Weather Over Ocean," Science News Letter, August 24, 1946, p. 120. Poor weather conditions high above the ocean, and at an altitude so high that it may never disturb surface conditions will be located and tagged by radar when a series of storm detaching stations are completely established by the army.

"Undersea Regions Studied," Science News Letter, August 17, 1946, p. 99-100. Great depths of the sea and the storms that rage within it have begun to be unfolded. Weather forecasting, dependent to a great extent on knowledge of the sea, Movement of water, vertically and horizontally, and differences in temperature influence the humidity of the atmosphere creating great pressure areas, rain, great movements of air.

*Magazine volume number is deemed superfluous, and omitted.

Sea depressions likewise are treated in this article.

"2,000 Mile Short Wave," Science News Letter, June 29, 1946, p. 404. Study of weather conditions may extend the range of ultra-short wave radio and radar transmission, up to 2,000 miles. Three 220-foot towers have been constructed by the Army Air Force at 25 mile intervals. Front cover shows a portion of mechanism.

"Weather to be Studied at Extreme Heights," Science News Letter, April 13, 1946, p. 232. By method of rockets bearing automatic recording instruments (rocketsondes), the U. S. Navy plans to explore the upper air as high as in excess of 200 miles or 500,000 feet. Radar tracking will tell of the deflection of the soaring missile from its calculated line of flight, thus presenting notion of what winds blow at altitudes ten times as high or more than any airplane has ever flown.

"'Controls the Weather,'" Science News Letter, November 17, 1945, p. 310. Author believes that it may come to pass that such important dates as heavy frosts may become predictable a week in advance from solar observations. Changes in the sun's radiation are theorized to affect the earth's weather indirectly thru variations in the thickness of "E" layer in outer atmosphere. Daily reports from many ionization stations would enable reliable seven day forecasts.

"Radar Equipped Aircraft for Weather Forecasting," Science News Letter, September 8, 1945, p. 152. A reconnaissance aircraft is equipped with radar mechanism to get a picture of advance cloud formations on a special detecting screen. Approaching storms up to 200 miles away may be detected. These weather observation planes report information back to their bases every thirty minutes. Relay of data is made to bombers and fighters near storm areas.